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VOLUME II - FEASIBILITY STUDY
REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
FOR THE
93RD STREET SCHOOL SITE
(SITE NO. 9-32-078)
CITY OF NIAGARA FALLS
NIAGARA, NEW YORK

DEPARTMENT OF ENVIRONMENTAL CONSERVATION • NEW YORK STATE •

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ACRONYMS USED

RI/FS	Remedial Investigation/Feasibility Study
NYSDEC	New York State Department of Environmental Conservation
EPA	United States Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
SARA	Superfund Amendments and Reauthorization Act
NCP	National Contingency Plan
EDA	Love Canal Emergency Declaration Area
MSL	Mean Sea Level
NYSDOH	New York State Department of Health
GA	Class A Groundwater
ATSDR	Agency for Toxic Substances and Disease Registry
ARAR	Applicable or Relevant and Appropriate Requirements
RCRA	Resource Conservation and Recovery Act
USDA	United States Department of Agriculture
USLE	Universal Soil Loss Equation
ISV	In-situ Vitrification
HTFW	High Temperature Fluid Wall
SMW-1 etc.	Monitoring Wells installed by LEA
7135 etc.	Monitoring Wells installed by E.C.
MW-1 etc.	Monitoring Wells installed by RECRA
CDC	The Center for Disease Control
TCLP	Toxicity Characteristic Leaching Procedure

1 intro

1.0 INTRODUCTION

The purpose of this report is to evaluate potential remedial action alternatives for the mitigation of the contamination found at the 93rd Street School site in the City of Niagara Falls, New York. This report has been written to satisfy the requirements of the feasibility study phase of the Remedial Investigation/Feasibility Study (RI/FS) for the 93rd Street School site performed under Contract No. D-001319 with the New York State Department of Environmental Conservation (NYSDEC), Division of Hazardous Waste Remediation.

This report conforms with the guidance provided by the U.S.Environmental Protection Agency (EPA) in the document entitled "Guidance on Feasibility Studies Under CERCLA" (EPA/540/G-B5/003; June 1985), in Section 300.68 of the November 20, 1985 National Contingency Plan (NCP), and in a number of EPA memoranda concerning interim guidance following passage of the Superfund Amendments and Reauthorization Act (SARA) of 1986.

Included in this report are presentations of introductory background information, development and screening of potential remedial action technologies, development and screening of preliminary remedial action alternatives, development and analysis of the most promising remedial action alternatives, the recommended alternative and a conceptual design of the recommended alternative. In this section, pertinent introductory information related to the site, results of previous studies, the nature and extent of contaminated soils, the objectives of remedial action, and an overview of the feasibility study process are presented.

1.1 SITE BACKGROUND INFORMATION

1.1.1 SITE DESCRIPTION

A detailed description of site background information was presented previously in Section 1.1 of Volume I - Remedial Investigation

Summary. Therefore, this section will briefly highlight factors which are pertinent to the selection of a remedial action alternative for the site.

The 93rd Street School site and adjacent housing authority properties are located on 19.4 acres of land in the City of Niagara Falls, New York. This site is located less than one mile northwest of Love Canal and is included in the Love Canal Emergency Declaration Area (EDA). Boundaries of the site include Bergholtz Creek to the north, 93rd Street to the west, residential properties and 96th Street to the east, and Housing Authority Property and Colvin Boulevard to the south.

The site is relatively flat with typical elevations ranging from 572' to 574' above mean sea level (MSL). There is, however, an existing drainage swale in the central portion of the site which slopes from the southwest to the northeast and discharges into Bergholtz Creek. The only other significant slope at the site is present along the bank of Bergholtz Creek where the elevation drops to 565' above MSL.

Drainage at the site occurs primarily via the existing swale. However, there are a few surface drains in the vicinity of the baseball diamond. Although the exact location to which these surface drains discharge has not been determined, it appears that they may be discharging to Bergholtz Creek.

The bedrock underlying the site consists of an approximately 150 feet thick layer of dolomite and a thin layer of limestone. The bedrock slopes toward the south at a rate of 30 feet per mile.

Overburden overlying the bedrock varies in thickness from 25 to 27 feet, and consists of glacial till covered by layers of clay, silt, and fine sand. In the immediate vicinity of the school, layers of fill (ranging from 0 to 7.5 ft. in thickness) and a thin layer of topsoil (typically less than 1 ft. thick) have been deposited on top of the native overburden.

Groundwater flow at the site has a very low velocity. Groundwater contours for the site indicate the presence of a groundwater "mound" across the middle of the site in an east-west direction. The direction of groundwater flow out of this "mound" appears to be to the south-southwest from the southern end of the property and to the north-northeast from the northern end of the property.

Runoff and evaporation of precipitation far exceed percolation at the site due to the relatively low permeability of site soils. As a result, any potential aqueous phase transport of contaminants present in the organic fill material to off-site areas would occur primarily through erosion caused by superficial runoff rather than through percolation and movement with the groundwater.

1.1.2 SITE HISTORY

As described previously in the Remedial Investigation Summary, the 93rd Street School was designed in 1947 and constructed in 1950. Prior to construction of the school, a drainage swale crossed the site from the northwest to the southeast, intersected 93rd Street and east-lying properties and discharged into Bergholtz Creek. Between 1938 and 1951, this swale was filled with soil and rock debris followed by sand and silt sized carbon waste and finally by approximately 3000 cubic yards of materials from the 99th Street School which was located adjacent to Love Canal. Then a final layer of topsoil was placed over the entire site. Further discussion of the extent of the fill material and the degree of contamination will be presented later in this report.

1.1.3 PREVIOUS STUDIES

Studies of the 93rd Street School site have been performed since 1979 because of the problems associated with the Love Canal fill. These studies were described in detail in Section 1.1.3 of Volume I - Remedial Investigation Summary. The most pertinent findings of these studies are summarized on the following pages.

- The Earth Dimensions Inc. and NYSDOH studies defined the extent and thickness of the fill layer at the site and found no significantly high levels of beryllium.
- RECRA Research Inc. studies found low levels of lindane (gamma BHC), metals, and volatile organics in the fly ash fill layer. In addition, one sample (collected at MW-4 at a depth of 4 to 6 ft.) was found to be contaminated with 2.3 ppb of dioxin. Study of groundwater identified benzene and toluene at concentrations less than 20 ppb and 25 ppb, respectively, and other contaminants including halogenated organics, volatile halogenated organics, chromium, lead, zinc and iron at detectable concentrations. Finally, study of surface water samples from storm sewers identified lindane (gamma BHC) at concentrations of 15 to 97 ug/L while study of surface water samples from Bergholtz Creek identified trace levels of benzene, lindane (gamma BHC) and dioxin.
- NUS Corporation detected dioxin at three locations in the surface soils at the site. Dioxin concentrations at two of these locations were below 1 ppb (0.11 ppb and 0.19 ppb) while the dioxin concentration at station OS,OE was 1.2 ppb.
- E.C. Jordan Co., Inc. studied contamination in site soils and groundwater. Acetone, methylene chloride, benzene, toluene, and bis (2-ethylhexyl) phthalate were identified in the groundwater. All of these compounds were detected at levels lower than the NYSDEC GA effluent standards or guidelines with the exception of benzene which was detected in one sample at a concentration of 11B mg/L (Note that the B flag indicates that benzene was also detected in the method blanks). Similar contaminants at similar concentrations were detected in soil samples.

- Malcolm Pirnie, Inc. detected dioxin at concentrations ranging from ND to 0.73 ng/g in composite creek bank samples collected from the banks of Black Creek and Bergholtz Creek. Only one composite creek bank sample did not exceed the detection limit. This sample was collected from Black Creek upstream of the 93rd Street School. Dioxin was not found in two stormwater runoff samples collected from the 93rd Street School swale at levels exceeding the detection limits. The report concluded that there appeared to be a spatial relationship between the locations of sewer outfalls and the occurrence of high concentrations of dioxin in creek bank soils and creek bed sediments.

1.2 NATURE AND EXTENT OF SITE PROBLEMS

During the remedial investigation phase of this study, contaminants were not found in the groundwater or surface water at levels exceeding the Contract Required Detection Limits (CRDL's) and standards based on human health criteria. It should be noted, however, that for a number of compounds, NYSDEC water quality standards and guidance values are lower than the CRDL's that were used during the remedial investigation. Therefore, it was recommended that additional samples be collected and analyzed during the remedial design phase to ensure that the levels of groundwater contamination at the site do not exceed ARAR's.

Soils and sediments at the site were found to be contaminated with the parameters listed on the following page at levels exceeding background data and/or criteria developed from human health based aqueous standards.

Inorganic

*Antimony
*Arsenic
Cadmium
Cobalt
*Lead
*Mercury

Volatile Organics

Methylene Chloride
1,1 Dichloroethene
Chloroform
1,1,2,2-Tetrachloroethane
Toluene
Ethylbenzene
Xylenes

B/N/A Organics

Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
*Benzo(a)anthracene
*Chrysene
*Benzo(b)fluoranthene
Benzo(k)fluoranthene
*Benzo(a)pyrene
*Indeno (1,2,3-cd)pyrene

Pesticides/Dioxin

Alpha BHC
Beta BHC
*Dioxin (only found by others)

Summaries of the concentrations of these parameters in site soils and sediments were presented in Section 3 of Volume I - Remedial Investigation Summary.

It should be noted that during the risk assessment, it was determined that not all of these parameters would contribute significantly to risks at the site. Thus the parameters denoted with an asterisk (*) above were considered, while others were eliminated. Further discussion of this process was presented in Section 6 of Volume I - Remedial Investigation Summary.

Dioxin contamination was not detected in any of the 29 composite soil samples collected and analyzed during the remedial investigation phase of this study. However, since the composite samples analyzed for this study did not typically include surface soils, the dioxin contamination data for site surface soils from the NUS Corporation Study is considered in this feasibility study. As described previously, NUS Corporation detected dioxin in three surface soil samples at the following locations and concentrations:

NUS Corporation Sampling Location (Grid Corner) See Drawing S-2	Dioxin Concentration (ppb)
0S, 0E	1.20
160S, 80E	0.11
160S, 160E	0.19

The locations of these NUS sampling locations are shown both on Drawing S-2 and on Figure 3 in Volume I - Remedial Investigation Summary. In addition to the NUS Corporation findings, RECRA Research, Inc. also detected dioxin on-site at one location (i.e. MW-4 at a depth of 4 to 6 ft.). The concentration of dioxin at this location was determined to be 2.3 ppb.

The Center for Disease Control (CDC) has recommended 1 ppb as the level of concern for dioxin in residential areas in the case of the Times Beach, Missouri site. Based on conversations with representatives of NYSDEC, it has been agreed that 1 ppb should also be used as the level of concern for dioxin at the 93rd Street School site. Additional justification for the use of 1 ppb as the level of concern in this study is the proposed land disposal ban that will go into effect this Fall. In summary, under RCRA, certain dioxin bearing wastes will be banned on November 8, 1988 from land disposal per the requirements of 40CFR268.31. The only exceptions to this ban will be wastes which have been treated sufficiently to pass the Toxicity Characteristic Leaching Procedure (TCLP) as described in Appendix I of 40CFR268, and wastes which have been granted an exemption or extension. In order to pass the TCLP test, the leachate from a dioxin bearing waste cannot contain dioxin at a concentration greater than 1 ppb.

As described previously, dioxin has only been identified at the 93rd Street School site at concentrations exceeding 1 ppb at two 'hot spot' locations. Soils from these hot spots should be treated such that the treated residuals are capable of passing the TCLP test prior to disposal. In addition, if other site soils are excavated and treated during remediation of the site, the treatment residuals from these soils should also be demonstrated capable of passing the TCLP test prior to disposal.

The quantities of soils present at each of the two known dioxin 'hot spots' have been computed based on the following assumptions for this feasibility study:

- At NUS Corporation sampling station OS,OE, surface soil contamination may extend to a depth of 1 foot within a 60 foot radius of station OS,OE. A radius of 60 feet was selected because it is known that dioxin was not detected at the adjacent stations (i.e. 80S,OE and OS,80E). Therefore, a circular area with a radius of 60 feet centered at station OS,OE was used to obtain an estimate of the extent of soils contaminated with greater than 1 ppb of dioxin in the vicinity of OS,OE. Using this circular area and a depth of 1 foot, a maximum volume of 420 cubic yards of soil was computed as possibly requiring excavation. The exact volume to be excavated should be further refined during the remedial design phase.
- At MW-4, it was estimated that soils may be contaminated with dioxin to a depth at least 1 foot below the depth at which RECRA found dioxin and within a 5' radius of this depth. The volume of contaminated soil was computed within a truncated cone with a lower diameter of 10' and an upper (surface) diameter of 38 feet, a total depth (height) of seven feet, and side slopes at an angle of approximately 26.5° (1 foot rise per 2 foot run) to ensure soil stability during excavation. The

volume of soil in this truncated cone is approximately 130 cubic yards.

Thus the total volume of dioxin 'hot spot' soils possibly requiring excavation equals the sum of 420 cu. yd. plus 130 cu. yd. or 550 cu. yd.

The extent of non-dioxin soil contamination which could impose a significant risk to nearby populations was determined during the remedial investigation. While contamination was typically greatest in the thickest fill layers located in the deepest portions of the historic swale, there was some contamination present in the thinner fill layers also. Therefore, a preliminary estimate of the volume of soil/fill potentially requiring remediation was developed based on the assumption that the entire volume of fill should be addressed. Additional study during the preparation of the risk assessment, however, indicated that in a 'hot spot' area directly to the east of the school, the levels of carcinogenic contaminants (i.e., arsenic, dioxin and PAHs) were significantly greater than for the rest of the site. Figure 1 on the following page shows the extent of these 'hot spot' soils. The total volume of 'hot spot' soils was computed by the average end area method by comparing present day surficial contours with depths at least 1 foot below depths at which contaminants posing an unacceptable risk were identified in the risk assessment. The final volume of soil obtained by this method was approximately 6,000 cu. yds. (including dioxin hot spots). It should be noted that if this volume of soil were to be excavated and treated, an additional 25 percent of material might be removed using convential construction equipment during excavation. Therefore, for all off-site containment and all treatment alternatives evaluated in this report, a volume of 7,500 cu. yds. should be considered.

1.3 OBJECTIVES OF REMEDIAL ACTION

Based on the public health and environmental risk assessment presented in Section 6 of Volume I - Remedial Investigation Summary, it has been determined that the primary source of concern at the 93rd Street School site is the present of dioxin, PAH's and arsenic in the soils in the vicinity of the eastern side of the school as shown on Figure 1. In addition, there are some contaminants (particularly arsenic) present at other areas of the site which could pose a significant risk if not contained or treated. Uncontrolled site access, surface water and wind related erosion at the site or implementation of certain remedial actions could result in the development of one or moreof the following primary exposure pathways:

(1) Emission of fugitive particles into the air
(2) Direct exposure of humans and other life forms to contaminated soils

or possibly one or more of the following secondary exposure pathways:

(3) Transport of contaminated particles in surface water runoff
(4) Emission of volatiles into the air

Therefore, to protect human health and the environment, the primary objectives of remedial action at the 93rd Street School site will be to develop a method by which all of these exposure pathways can be addressed. It should be noted that significant groundwater contamination was not identified during this remedial investigation. However, since for a limited number of parameters the CRDL's exceeded NYSDEC standards and guidance values, additional sampling and analysis of the groundwater will be performed during the remedial design phase as described previously in Section 4 of Volume I - Remedial Investigation Summary.

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The remedial action alternative selected will be that alternative which best satisfies the following nine point criteria:

1. Compliance with Applicable or Relevant and Appropriate Requirements (ARAR's)
2. Reduction of waste toxicity, mobility or volume
3. Short-term effectiveness
4. Long-term effectiveness and permanence
5. Implementability
6. Cost
7. Community acceptance
8. State acceptance
9. Overall protection of human health and the environment

1.4 SUMMARY OF FEASIBILITY STUDY

As described previously in Section 1 of Volume I - Remedial Investigation Summary, the RI/FS process typically involves completion of 17 tasks. Tasks 1-10 are related to the Remedial Investigation, and therefore were described in Volume I. Tasks 11-17, however, are related to the Feasibility Study. These tasks are summarized in the following paragraphs.

1.4.1 TASK 11 - RESPONSE TO REMEDIAL INVESTIGATION

Site problems were identified based on the conclusions of the remedial investigation, and general response actions were developed.

1.4.2 TASK 12 - TECHNOLOGY MASTER LIST DEVELOPMENT

Remedial action technologies for each of the general response actions identified during Task 11 were researched and summarized.

1.4.3 TASK 13 - DEVELOPMENT OF ALTERNATIVES

Remedial action technologies were screened for technical feasibility and some technologies were eliminated from further consideration. Following screening, the remaining technologies were combined to form preliminary remedial action alternatives.

1.4.4 TASK 14 - SCREENING OF ALTERNATIVES

Preliminary remedial action alternatives were screened on the basis of their effectiveness in minimizing threats to human health and the environment, their technical feasibility, and their estimated magnitude of cost.

1.4.5 TASK 15 - EVALUATION OF ALTERNATIVES

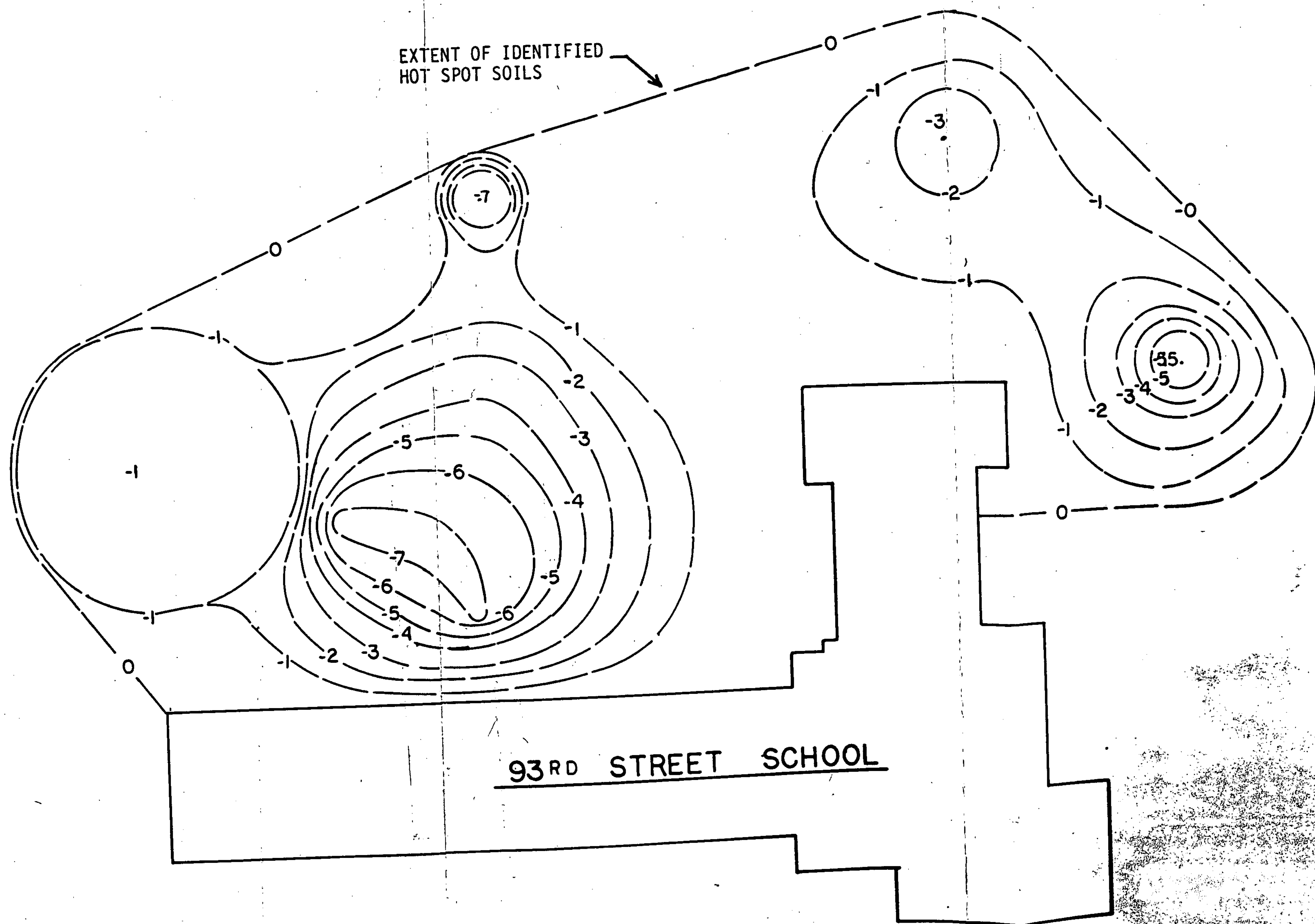
The final set of remedial action alternatives which passed preliminary screening were analyzed on the basis of a number of criteria including compliance with ARAR's; effectiveness in reducing waste toxicity, mobility or volume; short-term effectiveness; long-term effectiveness and permanence; implementability; cost effectiveness; community and state acceptance; and overall effectiveness in protecting human health and the environment. Following this analysis, the recommended alternative was selected.

1.4.6 TASK 16 - PRELIMINARY REPORT

A preliminary report was prepared and submitted to NYSDEC for review.

1.4.7 TASK 17 - FINAL REPORT

Following receipt of comments from NYSDEC concerning the preliminary Remedial Investigation/Feasibility Study Report, the preliminary report was revised as necessary, and a final report was submitted.



NOTE:
EXCAVATION CONTOURS SHOWN ARE APPROXIMATE AND ARE BASED ON REMOVAL OF MATERIAL TO A DEPTH AT LEAST ONE FOOT BELOW THE DEPTH WHERE SIGNIFICANT CONTAMINATION WAS FOUND.

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FIGURE 1 HOT SPOT EXCAVATION

by KR, KD	LK	1"=50'	3-25-

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2 - Techs

~~map should preceed this pg.~~

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2.0 DEVELOPMENT AND SCREENING OF REMEDIAL ACTION TECHNOLOGIES

The purpose of this section is to present brief summaries of the containment and treatment remedial action technologies which were considered as potential aids for mitigation of the problems associated with the contaminated soils at the 93rd Street School site. Following presentation of these technology summaries, the technologies are screened on the basis of their compatibility with site and waste characteristics and implementation feasibility. A table is presented at the end of this section which summarizes all technologies considered, their status regarding further evaluation, and reasons for eliminating non-feasibile technologies.

2.1 DEVELOPMENT OF TECHNOLOGIES

The following sections present brief descriptions of containment and treatment remedial action technologies including explanations of how these technologies could be used to remediate the 93rd Street School site and potential advantages and disadvantages of each technology with respect to site and waste characteristics and implementation feasibility.

2.1.1 CONTAINMENT TECHNOLOGIES

2.1.1.1 INTRODUCTION

Based on the conclusions of the public health and environmental risk assessment, containment technologies could be used at the 93rd Street School Site to minimize risks associated with the contaminated soils located outside of the 'hot spot' area defined on Figure 1 or to contain the soils within the 'hot spot' area following proper treatment and testing of residuals. Containment of the 'hot spot' area soils without prior treatment and residuals testing might not be effective since permanent treatment of these soils would ultimately provide greater long-term protection of human health and the environment and would correspond more closely with the goals of the NCP.

Although it has not been determined whether or not the contaminated soils (including the fly ash fill) meet the criteria to be defined as hazardous under the Resource Conservation and Recovery Act (RCRA), it is likely that some aspects of RCRA containment and closure regulations are applicable or relevant and appropriate (i.e., ARAR's). Therefore, a brief summary of RCRA closure regulations is presented in this section followed by descriptions of containment technologies which could be used to address each of the primary and secondary exposure pathways described previously.

RCRA regulations include several closure options for land disposal facilities which could be used as remedial action technologies at Superfund sites. At the present time, there are two land disposal closure options under RCRA. These options are closure by removal or decontamination (clean closure) and closure as a landfill. Soon it is anticipated that a hybrid land disposal approach combining the two existing RCRA closure options will be allowed as a third option under the RCRA program.

Clean closure under RCRA requires that at the time of closure, levels of contamination in wastes must be below levels established by EPA as acceptable for inhalation, ingestion and dermal contact; while levels of contamination in leachate (i.e. groundwater) must meet drinking water standards or EPA recommended health based levels.

Landfill closure under RCRA requires full containment of hazardous materials and long-term management of these materials. Caps and liner systems must be designed in accordance with RCRA and more stringent state standards.

The proposed hybrid closure procedure would involve removing (or treating) the majority of contaminated materials and then allowing covers and post-closure monitoring programs to be designed based on the exposure pathway(s) of concern. This procedure was proposed on March 19, 1987 and it is anticipated that the EPA will promulgate a final regulation in May of 1988.

Based on this proposal, it appears that the most feasible containment option for the 93rd Street School soils and treatment residuals would involve the use of a hybrid closure cover and post closure monitoring program. The Superfund program has focussed on two options for hybrid closure and post closure monitoring. The first option is 'alternate clean closure' in which most hazardous contaminants can be demonstrated to be of minimal threat to groundwater or by direct contact, thus making containment unnecessary and minimizing post closure care requirements. Fate and transport modeling must be performed prior to approval of this option to ensure that the groundwater aquifer is usable. This option might be used to address the treatment residuals from the area defined on Figure 1.

The second option is 'alternate landfill closure' in which hazardous materials are removed or treated such that residuals pose a direct contact threat but are not a threat to groundwater (i.e., leachate contamination does not exceed health based levels). In this option, a permeable soil cover can be used to address the direct contact threats and some long-term management is required including maintenance and some groundwater monitoring. This option might be used to address the non hot spot soils, providing groundwater contamination is not identified during the remedial design phase.

EPA currently has the authority to implement the alternate closure options at Superfund sites in certain cases even though RCRA regulations have not yet been promulgated. The only exceptions include cases in which the current RCRA regulations are definitely applicable because the wastes have been demonstrated to be RCRA hazardous wastes and disposal of these wastes occurs.

For wastes which are contaminated with a RCRA land ban contaminant, (such as dioxin at concentrations exceeding 1 ppb) land disposal may be somewhat more complicated. Therefore, to minimize complications, it will be preferable to select a treatment alternative for the dioxin hot spot soils which will reduce dioxin contamination in the residuals to the point where they can pass the TCLP procedure and meet ARAR's associated with clean or hybrid closure requirements. This will make it possible to dispose of the residuals in a manner that is both cost effective and protective of human health and the environment.

In the following paragraphs, descriptions of a variety of potential containment technologies including capping, disposal in new or existing landfills, or disposal in new or existing storage units are presented. It should be noted that many of these technologies would not be necessary if groundwater problems are not identified at the site or treatment residuals are rendered delistable. They are described in detail, however, since they might be utilized in the unlikely event that treatment residuals cannot be disposed via the hybrid approach, or groundwater contamination is discovered during the remedial design phase which can be attributed to non hot spot contaminated site soils.

2.1.1.2 CAPPING

Capping technologies involve the placement of soil, clay, concrete, asphalt and/or synthetic membranes over a contaminated area to prevent humans and other life forms from coming into direct contact with wastes, to prevent wind and surface water erosion of soils which could potentially lead to migration of contaminants off-site, and to minimize groundwater flow through contaminated materials.

2.1.1.2.1 RCRA CAPS

Caps for RCRA hazardous waste facilities are typically designed in accordance with the RCRA regulations presented in Title

40 of the Code of Federal Regulations, Section 264.310 (i.e., 40CFR264.310), in related EPA guidance as presented in the document titled "RCRA Guidance Document for Landfill Design", in the document titled "Protocol for Evaluating Interim Status Closure/Post-Closure Plan" (August, 1986) and in more stringent state regulations. These regulations and guidance materials require that RCRA caps consist of three layers including a vegetative top layer, a middle drainage layer, and a bottom low permeability layer. Specific requirements for each of the RCRA cap layers are as follows:

- The vegetative top layer should be at least two feet thick and designed to support drainage and minimize erosion. Soils, vegetation and slopes of this layer are selected such that the United States Department of Agriculture (USDA) Universal Soil Loss Equation (USLE) can be used to demonstrate that soil erosion will not be excessive.
- The middle drainage layer should be at least one foot thick and designed to support drainage in a lateral direction. This layer is typically overlain with filter fabric to prevent potential plugging by fine earth particles carried down from the vegetative top layer.
- The bottom low permeability layer should consist of a synthetic membrane overlying a two foot thick layer of soil compacted to a saturated hydraulic conductivity of not more than 1×10^{-7} cm/sec.

When properly designed, the layers of a RCRA cap work together to provide long-term minimization of migration of liquids through the underlying soils, function with minimum maintenance, promote drainage, minimize erosion or abrasion of the cover, accommodate settling and subsidence such that the integrity of the cover is maintained, and have a permeability less than or equal to that of the natural subsoils.

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The primary technical disadvantages of RCRA caps are the need for long-term maintenance and the uncertain design life. Although caps designed in accordance with RCRA standards are constructed to require minimum maintenance, they must be inspected periodically for signs of settling, ponding of liquids, erosion, and invasion of deep rooted vegetation. Damage to RCRA caps should be corrected as necessary to prevent minor problems from becoming more serious.

In addition to inspecting and maintaining the cap, the groundwater monitoring wells must be inspected, sampled, and maintained. If monitoring indicates that contaminants are migrating due to damage to the cap, partial or even complete cap replacement may be necessary. According to EPA (Ref. 1), caps designed with both a low permeability layer and a synthetic membrane may have a design life greater than 100 years if the wastes remain unsaturated, and if proper maintenance procedures are observed. Because some of the wastes at the 93rd Street School site are located beneath the groundwater table during most of the year, however, the design life of an RCRA cap at the site might be somewhat shorter.

In conclusion, because it is anticipated that hybrid closure would be the most effective containment option for the 93rd Street School site, the only cases for which a RCRA cap might be feasible would be if there were no acceptable treatment alternatives capable of reducing contamination in site soils to levels acceptable for hybrid closure, or if additional groundwater sampling during the remedial design phase indicates the need for minimizing groundwater flow through the contaminated soils at the site.

2.1.1.2.2 Non-RCRA Caps and Covers

There are a variety of cap and cover designs and materials which do not meet the RCRA standards. Virtually impermeable, non-RCRA caps could be constructed by placing a single low permeability layer consisting of asphalt, concrete, or chemical stabilizers/sealants over the site. Commercially available sealants could be used to prolong the design lives of asphalt and concrete caps. Since at the present time significant groundwater contamination has not been identified at the site, however, it is anticipated that asphalt and concrete caps would not be applicable for this site.

If groundwater contamination is not found during the sampling to be conducted during the remedial design phase and treatment residuals can be disposed in a hybrid landfill, then a low permeability soil cover could be used to minimize direct contact risks at the site. Such a cap might consist of a layer of low permeability soil compacted and vegetated such that it is resistant to erosion, and graded to promote proper drainage.

2.1.1.3 ON-SITE DISPOSAL

There are many containment technology options for disposal of the contaminated soils from the 93rd Street School site immediately on-site or within the Love Canal Emergency Declaration Area including the following:

- Cut through the new Love Canal cap liner, deposit soils, and repair liner (i.e., disposal in an existing RCRA landfill).
- Construct a new RCRA landfill on top of the Love Canal cap or on the 93rd Street School grounds.
- Convert the 93rd Street School building into an interim storage facility (i.e., disposal in an existing structure).
- Construct a RCRA grade concrete vault* on the 93rd Street School grounds or elsewhere within the EDA.

* RCRA-grade storage facility (landfill or concrete vault) will be double lined with a leachate collection system, a leak detection system, a cap, and a contingency plan in case of failure. The facility would meet RCRA criteria in all respects.

In summary, each of these alternatives would involve implementation of one of the following technologies: disposal of contaminated soils in an existing capped landfill, disposal in a newly constructed RCRA landfill, disposal in an existing structure or disposal in a newly constructed RCRA concrete storage vault. Brief descriptions of each of these technologies are presented in the following paragraphs.

Placement of the contaminated soils in the existing Love Canal containment area would probably only be desirable if treatment residuals for soils from the hot spot area defined in Figure 1 could not be disposed on-site or at an established hazardous waste landfill. Steps involved would include excavation and treatment of site soils, testing of treatment residuals, transportation to the capped Love Canal facility, removal of a portion of the Love Canal cap liner, placement of the 93rd Street School soils, and repair of the cap. This alternative would definitely not be preferable since opening of the Love Canal Cap would increase the potential for exposure of the environment to more hazardous materials than the tested residuals from the 93rd Street School site, and there may not physically be enough room for placement of the residuals beneath the existing cap.

Construction of a new earthen bermed RCRA landfill facility would involve excavation of soils followed by the steps listed below:

- Construct earthen berms
- Fine grade base
- Install bottom liner
- Place and compact clay layer
- Install leak detection system
- Install second synthetic liner
- Place granular material and piping for leachate collection system
- Deposit soils and decontaminate
- Construct a RCRA cap (as described previously)

This alternative would also be used only if treatment residuals from the hot spot area defined on Figure 1 could not be disposed on-site or at an established hazardous waste landfill.

If the earthen bermed facility were to be constructed on top of the Love Canal cap, a hole would have to be cut in the HDPE liner followed by welding of a new bottom liner to the HDPE liner. It should be noted that CH_2M Hill eliminated construction of an earthen berm on top of the Love Canal cap for the same reasons as described previously (Ref. 2). Construction of earthen berms at the 93rd Street School or inside the Love Canal fenceline, however, were considered to be technically feasible options by CH_2M Hill. These options might not be feasible for the 93rd Street School soils, however, since unless groundwater contamination is found during the remedial design phase or treatment residuals cannot be disposed in a hybrid landfill, a simple low permeability cover would probably achieve virtually the same degree of protection with lower costs and short-term risks.

Current EPA/RCRA guidance requires new landfills to have a double liner system and two leachate detection, collection and removal systems. An earthern berm could be constructed in accordance with this guidance to ensure that the liners are compatible with site and waste characteristics, that the foundation is stable, that direct contact between wastes and leachate and surrounding soils is prevented, and that the structure is inspected periodically to ensure adequate performance.

Leachate collection systems for new RCRA landfills consist of a drainage layer at least one foot thick composed of a soil with a hydraulic conductivity greater than or equal to 1×10^{-3} cm/sec and a minimum slope of two percent. This layer is placed directly above a secondary clay liner with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. In addition, a filter is placed over the drainage layer to prevent infiltration of fines and subsequent clogging. Leachate collection pipe networks are designed in accordance with EPA guidance and more stringent state standards.

The primary RCRA landfill liner system can consist of a soil or a synthetic membrane. However, according to EPA, synthetic membranes are usually preferable for long term containment. There are many different synthetic membrane materials to choose from. For the 93rd Street School site, a synthetic membrane would have to be resistant to cold temperatures and soil organics and easy to seam and repair.

Soil should be placed and compacted in a landfill in a series of cells to prevent excessive quantities of rainfall from entering a single large cell. In addition, efforts to prevent run-on of rainwater would be required.

Following completion of placement of contaminated soils in an on-site landfill, the landfill would have to be closed in accordance with ARARs. This might necessitate placement of a RCRA cap as described previously.

During both the operating life of the landfill and the post-closure period, inspections would be required to ensure the proper operation of the water controls and cap integrity. In addition, a groundwater monitoring system consisting of a minimum of one upgradient and three downgradient wells would be necessary to ensure that the groundwater was not being contaminated. Typically EPA requires that these systems be sampled semi-annually and that samples be analyzed for site specific indicator parameters for a period of approximately 30 years.

It should be noted that potential technical disadvantages associated with construction of a landfill at the 93rd Street School site include the facts that the site has a relatively high groundwater table, and freeze/thaw effects may adversely affect the design life of an on-site landfill. Finally, it should also be noted that according to EPA (Ref. 1), on-site landfilling is not typically considered to be feasible unless one or more of the following conditions apply:

(1) There is so much waste to be disposed that costs of on-site disposal will be comparable to acceptable off-site disposal.

(2) Simple capping of the site will not provide adequate protection of human health and the environment; and

(3) On-site conditions will allow for the construction of a landfill that will protect human health and the environment.

Placement of the contaminated sediments from nearby creeks in the 93rd Street School was considered by CH_2M Hill (Ref. 2) in another study but was eliminated as an alternative due to the fact that the building was not designed to contain contaminated soils and use of it for this purpose would not be technically feasible. In addition, this option would not allow for reopening of the school.

Construction of a new RCRA grade concrete vault facility would involve the following steps:

- Excavate soils and install synthetic membrane
- Place drainage gravel and geotextile layers
- Pour 8" reinforced concrete and coat with polymeric asphalt
- Place drainage gravel and geotextiles to act as a leachate collection system
- Similarly construct concrete sidewalls
- Deposit soils and decontaminate all contacted equipment
- Construct RCRA cap as described previously

CH_2M Hill considered this technology to be technically feasible if implemented at the 93rd Street School site or within the Love Canal fenceline. It was not considered feasible, however, for implementation at the LaSalle housing development due to time considerations related to procuring the property and conducting engineering studies (Ref. 2). As for the RCRA earthen bermed facility, construction of a concrete vault would probably not be necessary for disposal of the 93rd Street School soils since a cap would probably achieve virtually the same degree of protection at a lower cost and short-term risks.

2.1.1.4 OFF-SITE DISPOSAL

The principle technology available for off-site disposal of soils from the 93rd Street School site is land disposal at an EPA approved off-site landfill. Landfilling of soils off-site would make it necessary for the wastes to be handled in accordance with ARARs including the RCRA and more stringent state regulations. These regulations describe how to identify wastes as hazardous, how to manifest hazardous wastes, and how disposal facilities should be operated in accordance with RCRA regulations.

There are at least two hazardous waste landfills located near the Love Canal. These landfills are owned and operated by CECOS and SCA. Preliminary discussions with representatives of each of these facilities suggested that while they would not be willing or able to accept untreated soils from the site (primarily because of the dioxin hot spots), they might be willing to accept treated residuals.

2.1.2 TREATMENT TECHNOLOGIES

There are a variety of treatment technologies which could be used to treat the contaminated soils within the 'hot spot' area defined on Figure 1 in-situ, on-site, or off-site. Discussions of these treatment technologies are presented in the following sections.

2.1.2.1 IN-SITU TREATMENT TECHNOLOGIES

In-situ treatment technologies involve the use of biological or chemical agents or physical manipulation to degrade, remove, or immobilize contaminants. In the following sections, descriptions of biological, chemical and physical in-situ treatment technologies are presented.

2.1.2.1.1 BIORECLAMATION

In-situ bioreclamation technologies involve the use of biological agents to break down organic contaminants in soils. Typically, successful biological treatment requires that soil conditions be optimized to stimulate the growth of the particular microorganism(s) which are capable of breaking down the contaminants of concern. Either native micro-organisms or genetically engineered organisms may be introduced into the soil. If it is desired to degrade more than one contaminant compound, it may be necessary to treat the soil first under aerobic conditions then under anaerobic conditions or vice versa.

Factors which could affect the technical feasibility of biological in-situ treatment at the 93rd Street School site include the following:

- There are a broad range of organic and inorganic contaminants at the site even in the hot spot soils. Therefore it would be difficult to develop/isolate a group of micro-organisms capable of degrading and/or detoxifying all contaminants (particularly the inorganic metallic contaminants).

- Biological degradation of dioxin in natural soil systems has not been demonstrated effective and will probably not be possible for at least three years (Ref. 2) due to factors including isolation of an effective microbe, propagation of a large enough population of the microbe, provision of adequate nutrients, control of environmental factors, and achievement of adequate treatment in the low ppb range. Thus even if the majority of the contaminated soils could be treated by this technology, dioxin hot spots would have to be remediated by another method.

- The site is located in an area which has relatively cold winters. Thus during winter months, microbial activity would be inhibited. According to EPA, for every 10°C decrease in temperature below the optimum range of 20°-37°C, enzyme activity is halved (Ref. 1).

- The relatively low hydraulic conductivity of the native site soils might inhibit uniform distribution of microorganisms throughout the contaminated fill and therefore result in non-uniform levels of treatment across the site.

2.1.2.1.2 CHEMICAL TREATMENT

In-situ chemical treatment technologies are typically used to immobilize, mobilize for extraction, or detoxify organic or inorganic contaminants. Immobilization of contaminants can be achieved by introducing chemicals which are capable of precipitating, chelating, or polymerizing undesirable contaminants. These techniques can help prevent contaminants from leaching out of the soil matrix by rendering them insoluble.

Precipitation technologies are typically employed to render heavy metal contaminants insoluble. Chemicals commonly added to induce precipitation include sulfides, carbonates, phosphates and hydroxides. It should be noted that at the 93rd Street School, addition of phosphates would be undesirable due to the presence of arsenic which might be converted to arsenate and released from the soil matrix (Ref. 3). The pH and rate of addition of precipitating agents would have to be carefully controlled to ensure that complexes which were more mobile than the free metallic ions were not formed. The primary disadvantage of precipitation agent addition would be that the complexed metallic ions present in hot spot soils would achieve maximum precipitation over a wide range of pHs. Therefore, it would be difficult to precipitate/effectively immobilize all of the metals of concern at once.

Chelating technologies involve introduction of chelating agents which attach themselves with coordinate links to central metal ions to form heterocyclic rings. Some of these rings are relatively immobile because they are strongly sorbed to clay in soils.

Polymerization technologies are used to immobilize contaminants by trapping them in a gel-like mass. This technology involves injection of a catalyst into the groundwater to polymerize an organic monomer. Since organic monomers are not believed to be present in the 93rd Street School fill, this technology does not appear feasible.

In-situ chemical detoxification techniques include neutralization, hydrolysis, oxidation/reduction, enzymatic degradation, and permeable bed treatment. Neutralizing agents are added to soils to adjust the pH. Since the soil pH at the 93rd Street School is not perceived to be a problem, neutralizing agents are not required.

Hydrolysis typically involves the addition of a waterbase mixture to degrade compounds such as esters, amides, carbonates, organophosphorous compounds and some pesticides. Since the majority of these contaminants are not parameters of concern for the 93rd Street School soils, hydrolysis does not appear feasible.

Oxidation techniques involve introduction of oxidizing agents to reduce concentrations of lead and arsenic in soils or to detoxify organics such as benzene, phenols, nitro aromatics, PAHs, heterocyclic nitrogen and oxygen compounds, aldehydes, ketones, sulfides and disulfides. Use of oxidation to address the contamination in the soils at the 93rd Street School might prove difficult since no single oxidizing agent will address all of the contaminants present, and there is a potential for more toxic or mobile degradation products to form as a result of oxidation.

Reduction techniques involve the introduction of reducing agents such as ferrous sulfate to reduce hexavalent chrome to trivalent chrome or hexavalent selenium to tetravalent selenium. Since these metals are not parameters of concern in the soils at the site, reduction technologies are not considered feasible.

Enzymatic degradation involves use of enzyme extracts from microbial cells to detoxify wastes such as organophosphates and pesticides (diazinon). Since this technology could only potentially be used to address a few of the contaminants at the site, it does not appear feasible.

Permeable treatment beds are excavated trenches filled with treatment materials through which groundwater will flow and be treated. Materials placed in these trenches typically include lime and glauconitic greensand (for metals removal) and activated carbon (for non-polar organics removal). The primary problem associated with use of permeable treatment beds at the 93rd Street School site is the fact that based on currently available data, the contaminants of concern are not leaching in significant quantities into the groundwater.

Four chemical treatment technologies which have been evaluated by others for remediation of dioxin contaminated soils include chemical degradation by chlorination, catalytic oxidation, chloroiodide degradation and dechlorination.

Chlorination involves the reaction of gaseous fuel materials with chlorine at high pressures (i.e. 200-700 atm) and temperatures (up to 800°C). This procedure has been used to treat liquid Agent Orange successfully, but information concerning treatment of dioxin in a soil matrix is not yet available.

Catalytic oxidation involves dissolving dioxin in a non-nucleophilic solvent and reacting it with ruthenium tetroxide. This procedure has been used in laboratory studies, but the high cost and high toxicity of ruthenium tetoxide make catalytic oxidation infeasible for full-scale operations (Ref. 2).

Chloroiodide degradation involves contacting contaminated media with chloroiodides in micellar solutions at ambient temperatures. Thus far, available literature indicates that this technology has only been used on a small scale in laboratory experiments.

Finally, dechlorination involves removal of chlorine atoms from dioxin molecules by introducing chemical reagents. Once the chlorine atoms are removed, the toxicity is reduced and the final product can be further treated or disposed. This process has been proven successful on liquid samples in laboratory experiments. Large scale testing with contaminated soils, however, has not been conducted.

2.1.2.1.3 PHYSICAL TREATMENT

Physical in-situ treatment technologies including in-situ heating, vitrification, and artificial ground freezing can be used to immobilize or detoxify waste constituents. Each of these technologies is described briefly in the following paragraphs.

In-situ heating technologies such as steam injection and radio frequency heating can be used to reduce the levels of some of the organic compounds in soils. These methods are not capable, however, of reducing the concentrations of metals and some complex organics. Thus in-situ heating does not appear to be a feasible technology for treatment of the site soils.

Artificial ground freezing involves use of freezing plates to immobilize soil contaminants. According to EPA, (Ref. 1) the high cost of operating the soil freezing apparatus renders this technology effective only as a temporary remedy.

In-situ vitrification (ISV) is a thermal treatment process in which contaminated soils are converted into a chemically inert glass and crystalline product resembling natural obsidian. This product is capable of retaining its physical and chemical integrity over geologic time periods. The ISV process involves placement of four electrodes in a soil mass through which an electric current can be passed. When the current is applied, the adjacent soils are heated to temperatures of up to 3600°F. As a result, soils and rocks melt while other inorganic materials such as metals are encapsulated in the vitrified mass. Organic materials in the soil pyrolze, diffuse to the soil surface, and combust as a result of the temperature increase. Therefore, to prevent air pollution, a hood is placed over the processing area to collect off gases. These off gases are then treated (i.e., cooled, scrubbed, sorbed, and heated) in a system which includes a glycol gas cooler, a wet scrubber, a heater, a charcoal filter assembly and a blower system.

Bench and engineering scale testing of the ISV process on soils contaminated with cyanides, heavy metals (including cadmium, lead and cobalt), and various organics (including dioxin) have been performed. Results of these tests are as follows:

- TCLP and EP toxicity testing of treatment residuals from soils contaminated with inorganics have indicated that the final product can be delisted.

- Dioxin treatment efficiencies of 99.999 percent have been achieved in bench scale testing.

It should be noted, however, that Battelle Pacific Northwest Laboratories claims that information on the use of ISV to treat soils contaminated with dioxin and low boiling point organics is very limited. Therefore, feasibility studies involving the soils from the 93rd Street School site would be required if this technology were selected.

Finally, it should also be noted that there are some significant disadvantages associated with the ISV process including the fact that according to EPA (Ref. 4), the Battelle ISV system "...is best suited where processing at depths of greater than approximately ten feet is required. If contamination is near the surface (as is the case at the 93rd Street School), it would be more economical to remove the soil and stage it in a deeper trench for ISV processing." In addition, this process becomes very costly when the soil moisture content is high. Because of the high groundwater table at the 93rd Street School site, it is anticipated that the soil moisture content would be very high if in-situ vitrification were attempted. In conclusion, ISV would not be technically feasible for in-situ treatment of soils at the 93rd Street

School site primarily due to the fact that the contaminated soils are situated at shallow depths of less than 10 feet below the ground surface and the groundwater table is relatively high. Vitrification might be feasible, if the soils were removed, dried, and placed in deeper trenches elsewhere within the EDA. However, procurement of a site for vitrification of the materials might prolong the remediation process.

2.1.2.2 ON-SITE STABILIZATION/SOLIDIFICATION TECHNOLOGIES

Stabilization and solidification technologies are used to improve waste handling characteristics, to decrease the surface area from which contaminants may leach, and to limit the solubility or toxicity of certain contaminants. Stabilization/solidification technologies including cement based solidification, silicate based solidification, sorbent addition, thermoplastic solidification, and surface microencapsulation are described in the following sections.

2.1.2.2.1 CEMENT BASED SOLIDIFICATION

Cement based solidification is a technology in which wastes are mixed with Portland cement to form a solid or crumbly soil-like mass. The consistency of the final product is dependent upon the original waste characteristics and the quantity of cement added. Metals are typically immobilized because of the high pH of the cement mixture which leads to the formation of insoluble metal hydroxides or carbonates.

Potential problems associated with implementating conventional cement based solidification at the 93rd Street School site are that the organic contaminants would not be immobilized; the volume and weight of the wastes could increase by as much as 100 percent (although this is not always the case); and the presence of silt, clay and organic matter could potentially interfere with the curing of the cement waste mixture.

2.1.2.2.2 SILICATE BASED SOLIDIFICATION/STABILIZATION

Silicate based solidification/stabilization is performed by adding a silicate material (such as fly ash, blast furnace slag, soluble silicates or other pozzolanic materials) and lime, cement, gypsum or other setting agents to the waste. Addition of these materials along with a variety of proprietary additives, such as surfactants and emulisifiers can result in the stabilization of a broad range of contaminants including divalent metals, oils, and organic solvents. Stabilization occurs when the silicate reacts with polyvalent metal ions in the waste or in an additive thereby forming a solid mass which can vary in consistency from a moist cohesive clay-like material to a material resembling concrete. A number of processes have been developed which are capable of stabilizing wastes contaminated with both metals and organics. These processes include a process developed by Hazcon, Inc., a process developed by Soliditech, Inc. and the Chemfix process developed by Chemfix Technologies, Inc.

Hazcon, Inc. has developed a process in which a proprietary polymer based formula is mixed with a waste and a pozzolanic material. The resulting product is a hardened, leach resistant mass that can typically be landfilled. If organics are present in the waste, a reagent called Chloranan can be added during mixing to coat the organic molecules thereby preventing them from inhibiting the normal crystallization of the pozzolanic material. Once mixed, the resulting slurry can then be pumped or poured into the ground prior to setting. Volume changes as a result of this process are typically in the range of a 30 to 70 percent increase. Currently available data indicates that this process is effective for immobilizing heavy metals and organics, and testing of treatment residuals has indicated that it is possible to meet delisting requirements for many wastes. No large scale testing data is currently available, however, for the treatment of wastes contaminated with VOCs, PAHs or dioxin. Therefore, a feasibility study involving wastes from the site should be conducted prior to implementation of this technology.

Soliditech, Inc. has developed a similar process in which contaminated wastes can be chemically stabilized/solidified as a result of mixing with pozzolanic agents, water and liquid reagents including URRICHEM. Advantages of this technology are the facts that the mixer can be equipped to control volatile emissions, the manufacturer believes that it is capable of addressing all of the contaminants in the 93rd Street School soils and that it is likely that the final product following treatment would be delistable.

Chemfix Technologies, Inc. has developed a process in which soluble silicates, setting agents, and additives are mixed with wastes in proportions which vary depending upon the contamination. Each waste to be treated is first subjected to bench scale testing in Chemfix's labs to determine the types and quantities of additives required. Once this testing is completed and approvals are obtained, remediation in the field can be initiated. In the field, this treatment process involves excavation of contaminated soils followed by pulverization and slurrying and then feeding into the treatment system which consists of a dry reagent silo, a liquid reagent tank, a pubmill, load cells, skids and associated motor controls and instrumentation. Reactions which occur as the waste is mixed with the necessary additives include the precipitation of amorphous colloidal silicates, precipitation of metals within the physical structure of the silicate colloids, water hydrolysis and water hydration. As a result of these reactions, most heavy metals become part of the complex silicates while water, organics (including PNA's and dioxin according to Chemfix) and small quantities of heavy metals are immobilized between the complex silicates. Treatment residuals are tested on a daily basis, and materials not meeting treatment criteria are reprocessed. The final product from this process resembles a stabilized clay-like soil. Current data indicates that it is likely that this process could be used to treat the 93rd Street School site soils resulting in a delistable product capable of passing the TCLP test for dioxin.

Technological drawbacks of the silicate based solidification technologies include the facts that a number of waste constituents may inhibit the stabilization and/or solidification efficiencies of the additives, and large amounts of water often leach from the solidified mass following treatment. This water sometimes contains contaminants thus secondary containment may be required following treatment. Preliminary discussions with Chemfix representatives indicate that secondary containment of residuals treated by the process would probably not be necessary in the case of the 93rd Street School soils.

2.1.2.2.3 <u>SORBENT ADDITION</u>

Natural or synthetic sorbent materials are sometimes added to wastes to eliminate free liquids and to improve handling characteristics. Absorbent materials typically used include fly ash, kiln dust, vermiculite, bentonite, activated carbon, and synthetic sorbents designed to sorb specific types of contaminants such as volatile organics.

Disadvantages of sorbent addition include the fact that waste volume may increase, not all contaminants can be addressed, and secondary containment would almost definitely be required following treatment.

2.1.2.2.4 <u>THERMOPLASTIC SOLIDIFICATION</u>

Thermoplastic solidification technologies involve drying, heating, and dispensing a waste through a heated matrix such as asphalt bitumen, paraffin, or polyethylene. Asphalt is typically used for wastes containing heavy metals to form a solid.

Waste Chem Corporation has developed a mobile volume reduction and solidification system in which wastes are fed simultaneously with asphalt or plastic into a heated extruder/evaporator. As a result, free water and VOC's evaporate while other contaminants are immobilized in the asphalt or plastic waste mixture. The mixture is discharged from the unit in liquid form and then hardens to form a free-standing solidified mass at ambient temperatures. To prevent air pollution, the evaporated VOC's and water vapor are condensed and treated via carbon adsorption and HEPA filters. This process has been proven effective for the immobilization of heavy metals and PNAs in refining sludges. However, there has been little or no experience in treating soils contaminated with VOC's, pesticides, or dioxin according to the manufacturer.

Advantages of thermoplastic solidification over cement based processes include the facts that the volume increase and rate of leaching are typically reduced. Solidifying soils which contain organics in addition to metals can be complicated, however, since the organics tend to soften the asphalt and diffuse through it. In addition, because of the plasticity of and potential for leaching from the final waste mixture following treatment, secondary containment of the final product is typically required.

2.1.2.2.5 SURFACE MICROENCAPSULATION

There have been a number of technologies developed to microencapsulate wastes by sealing them in a binder. These technologies can be used to completely isolate wastes from leaching solutions as well as from direct air and surface water contact which could lead to off-site migration of contaminants. Typically these technologies are employed when wastes are going to be stored, then transported and disposed at an off-site location. This results in efficient space utilization, elimination of the potential for spills, and waste in a form which is better able to withstand the physical and chemical stresses that may be posed during disposal.

2.1.2.3 ON-SITE THERMAL TREATMENT TECHNOLOGIES

A variety of transportable thermal destruction units have been developed in recent years to destroy hazardous wastes. Typically, these units are designed such that they are very similar to fixed thermal treatment units which use high temperatures to degrade organic compounds in hazardous wastes into a variety of gaseous and solid by-products. Most of the mobile thermal treatment units are equipped with various combinations of the following components:

- Waste storage container(s)
- Waste sorting devices
- Waste drying devices
- Waste feed system
- Fuel or thermal energy introduction systems
- Primary thermal treatment tank(s)
- Secondary thermal treatment after burner(s)
- Ash collection system(s)
- Air pollution control system(s)

Following treatment, the resulting ash byproducts must typically be delisted if non-RCRA disposal methods are desired because of the potential presence of residual organics and heavy metals. It should be noted that if the dioxin hot spot soils were to be incinerated/thermally treated, the selected technology would have to be capable of achieving 99.9999 percent removal efficiency per EPA regulations. Typically, to achieve this removal efficiency, the dioxin must first be vaporized at a temperature in the range of 1300°F to 1800°F and then destroyed at a temperature greater than 2200°F (Ref. 2).

Brief descriptions of mobile thermal destruction units which could be used at the 93rd Street School site are presented in the following sections.

2.1.2.3.1 MOBILE ROTARY KILN INCINERATION

Rotary kiln incinerators have been proven effective for thermal destruction of liquid and solid hazardous wastes. Typically, a rotary kiln incinerator consists of the following components: waste storage hopper, primary rotary kiln chamber, secondary afterburner chamber, flue gas scrubbing system and ash removal system. Wastes are fed from the storage hopper into the rotary kiln which has been heated by combustion of fuel. The rotary kiln rotates constantly to ensure effective heat transfer efficiency. During heating, organics from the waste volatilize, and are heated further in the secondary afterburner chamber while the solid residual ash is removed. Following destruction in the afterburner, the residual gasses are passed through a flue gas scrubber system which removes air pollutants.

There are a number of mobile rotary kiln incinerators either currently available or being developed. According to EPA (Ref. 4), these include units manufactured by the following companies:

- ENSCO/PYROTECH
- DETOXCO (not yet built)
- EPA MOBILE UNIT (fabricated by DETOXCO)
- PEDCO(has built cascading rotary incinerators which are a variation of rotary kiln incinerators).
- FULLER POWER CORP. (not yet built)

Because the soils from the 93rd Street School which are being addressed by this feasibility study would contain low levels of dioxin, low levels of alpha and beta BHC, and no PCB's, it is presumed that most of the above units would be capable of addressing the organic contaminants in soils from the site. They might not, however, address the heavy metals contamination. Depending on the operation temperatures, it is anticipated that some metals would be volatilized and present in the residual gases while others would be present in the ash. This might make delisting the ash difficult. In addition, removal of volatilized metals from the residual gases might prove difficult because of the extremely small sizes of the metals present as a vapor. Another potential disadvantage of these technologies is that since the contaminated fill materials have relatively high moisture contents because of the groundwater table, thermal efficiencies and feed rates might be relatively low without prior soil drying. Based on estimates provided by CH_2M Hill (Ref. 2), incineration of 7,500 cubic yds. of hot spot soils from the 93rd Street School site might take approximately 2 to 14 months.

2.1.2.3.2 CIRCULATING BED COMBUSTION INCINERATION

A Circulating Bed Combustion (CBC) incinerator is a variation of a fluidized bed incinerator in which the fluidized bed operates at higher velocities and is recirculated. Conventional fluidized bed incinerators consist of a single chamber which contains a bed of inert granular material on top of a perforated metal plate. Hot air is introduced from beneath the plate, and it rises up through the plate and into the inert granular material. As a result of this hot air flow, the bed becomes fluidized (i.e., it mixes turbulently). Waste material is introduced into the bed and is combusted at temperatures typically ranging from 1400-1600°F. Air pollution controls are used to treat the resulting flue gases.

According to EPA (Ref. 4), Mobile CBC incinerators have been developed by Ogden Environmental Services. These units have been demonstrated effective in treating wastes containing high levels of PCBs and trichlorobenzene and have been approved for use by EPA in treating PCB contaminated soils. The feed rates of existing units are similar to those for the mobile rotary kiln incinerators described previously. Therefore it is presumed that total times required for treatment would be similar. In addition, it is anticipated that similar problems related to waste moisture content, metal vapors in the residual off-gases and residual ash delisting would be demonstrated by the mobile CBC.

2.1.2.3.3 ADVANCED ELECTRIC REACTORS

Advanced electric reactors (AERs) destroy organics in solid wastes by pyrolysis. These reactors typically consist of the following components: solids preparation systems (to reduce moisture content to below 3 percent), feed systems, a reactor chamber, two post reactor zones and air pollution controls. Feed rates for AERs can vary significantly. Relatively efficient units include an existing unit manufactured by J.M. Huber capable of processing 1.5 tons per hour of soil at 20 percent moisture content, and a unit owned by Westinghouse capable of processing up to 35 tons per/day (i.e., 1.5 tons per hour). Utilizing either of these units would result in a total treatment time similar to that for a mobile rotary kiln or CBC unit as described previously. It is anticipated that residual ash delisting might be difficult since metals would not be destroyed but instead would be present in a glass matrix. In addition, J.M. Huber is not currently accepting toxic or hazardous wastes at its facilities.

2.1.2.3.4 INFRARED FURNACES

According to EPA, Shirco Infrared Systems has developed small mobile infrared furnaces capable of handling 100 lbs/hr or larger units capable of handling 5 to 8 tons/hr of contaminated soils. The smaller units (100 lbs/hr) would probably not be feasible for use on the 93rd Street School soils due to the time it would take to process a minimum of 7,500 cu. yd. of soil. The larger units, however, would be feasible in terms of implementation time. It should be noted that the smaller units have been demonstrated effective for treating soils contaminated with creosote, penta-chlorophenol and dioxin. It is anticipated that some metals would volatilize and others would remain in the ash thus making it necessary to prevent air pollution and possibly difficult to delist the ash residue.

2.1.2.3.5 PLASMA ARC PYROLYSIS

Plasma arc pyrolysis involves use of a gas which has been energized to its plasma state by an electrical discharge to pyrolyze liquid and organic solid wastes. Existing mobile units manufactured by Westinghouse Plasma Systems have been proven successful in treating a variety of organic liquids and sludges. They are not, however, applicable for thermal destruction of organics in a soil matrix. Westinghouse Plasma Systems recently developed an electric pyrolyzer capable of handling 5 tons/day of soil at 20% moisture content (Ref. 4). However, test burn data for contaminated soils is not yet available.

2.1.2.3.6 HIGH TEMPERATURE FLUID WALL REACTORS

High temperature fluid wall (HTFW) reactors consist of a porous cylindrical core of refractor material in which the waste is placed. Infrared radiation is supplied to the core by electrodes on the reactor vessel jacket. An inert gas is drawn through the core during thermal treatment to prevent damage to the core due to contact with the waste which may be heated to 4000°F. Wastes are heated rapidly and completely in the core to ensure high thermal destruction efficiency.

According to EPA (Ref. 4), Thagard Research Corporation has developed a mobile HTFW reactor capable of handling 1.5 to 2.0 tons/day of soil at 20 percent moisture content. Use of this unit is similar to the mobile AER's owned by J.M. Huber Corporation. Feed materials must be finely ground prior to treatment, and metals are encapsulated in a glass-like waste which may be difficult to delist. Testing of this unit with soils contaminated with 80 ppb of dioxin at Times Beach, Missouri resulted in a final product with a dioxin concentration of less than 0.1 ppb. (Ref. 2).

2.1.2.4 OFF-SITE THERMAL TREATMENT

There are many different types of fixed thermal treatment units which are capable of destroying organic contaminants in soils. CH_2M Hill investigated the feasibility of building a fixed thermal treatment facility at Love Canal and determined that this would only be feasible if the quantity of sediments to be treated would exceed 100,000 cu. yds. (Ref. 2). Since the proposed quantity of soil to be treated at the 93rd Street School site is much less than 100,000 cy. yds., construction of a fixed thermal treatment facility at the site would not be feasible.

As for the mobile units described previously, it is anticipated that the metals concentrations in the ash from fixed thermal destruction facilities might inhibit delisting without additional treatment. However, in the following sections, brief descriptions of existing fixed off-site thermal treatment facilities are presented.

2.1.2.4.1 OFF-SITE ROTARY KILN INCINERATION

Off-site rotary kiln incinerators would operate in a manner essentially the same as described for mobile rotary kiln incinerators. In an assessment of fixed off-site rotary kiln incinerators to be used for creek and sewer sediments, CH_2M Hill and EPA evaluated the following facilities (Ref. 2):

- Rollins Incinerator; Deer Park, Texas
- SCA Chemical Services Incinerator; Chicago, Illinois
- ENSCO Incinerator; El Dorado, Arkansas
- Pyrochem Co. Incinerator; Coffeville, Kansas

None of these facilities is currently permitted or certified to treat dioxin contaminated wastes. Because these facilities are located relatively far away from the site, they were determined to be unlikely alternatives for treatment of the 93rd Street School soils particularly since similar degrees of treatment could be achieved on-site with a mobile unit without the additional transportation costs and associated risks.

2.1.2.4.2 OTHER FIXED OFF-SITE TECHNOLOGIES

In addition to rotary kiln incinerator facilities, there are off-site facilities using thermal destruction technologies not currently available in transportable units. Brief descriptions of thermal treatment technologies which were not described previously are presented in the following paragraphs.

A multiple hearth incinerator consists of a waste feed system, a combustion chamber with a series of flat hearths encircling a central rotating shaft, an air blower, a central ash removal system, fuel burners and a flue gas scrubber system. Solid wastes can be treated in these incinerators at temperatures ranging from 1400° to 1800° F following removal or pulverization of larger particles. These incinerators tend to have high fuel efficiency and an ability to evaporate large quantities of water. Disadvantages of these incinerators, however, include the facts that heat transfer is not as complete as in rotary kilns, metals may be present as a vapor in the residual gases and in the ash, and wastes containing ash (such as the fill materials from the 93rd Street School site) often form solid masses in the incinerators which are difficult to remove.

Molten salt incinerators maintain salt baths at temperatures of approximately 1400 to 1800°F. Wastes which are placed in the molten salt undergo catalytic destruction. Hot gases resulting from this thermal destruction are passed through a secondary reaction zone and then through an air pollution control system. These incinerators have been proven capable of handling solid wastes and destroying complex organics including 2,4-D chlordane, chloroform, PCB's, trichloroethane, and more than 99.9999 percent decomposition has been achieved (Ref. 2). Disadvantages of these incinerators, however, include sensitivity to wastes with high ash content, disposal problems associated with spent molten salt, potential buildup of arsenic salts and the fact that as of 1985, no units were known to be in commercial use (Ref. 2).

Wet air oxidation systems involve destruction of organic compounds in an aqueous matrix by introducing the waste and oxygen into a relatively high temperature (150°-350°C) and high pressure (500-2500 psig) reaction vessel. This technology has been applied commercially to sludges and pulps, but research in the application of this technology to soil treatment is necessary particularly for treatment of organics which are strongly linked to soils. It is anticipated that use of this technology for soils would require that the soils be pulverized, mixed into a slurry, and then mixed with a fuel source. No data on treatment of dioxin contaminated soils by this technology was available.

Supercritical water oxidation processes use air or oxygen above their critical temperature and pressure (i.e., 374°C and 218 atm) to thermally destroy organics. Wastes are slurried, pressurized and mixed with a base then introduced into the reaction chamber. By-products generated include salts, water, CO_2, inert materials, and traces of organics. Based on information from CH_2M Hill, no commercial units were using this technology for treatment of contaminated soils as of 1985, and additional research on treatment of dioxin contaminated soils is necessary (Ref. 2).

At-sea incineration has typically been used to thermally destroy toxic liquid hazardous wastes in a liquid injection incineration unit. Wastes which have been incinerated at sea include toxic organochloride compounds, herbicides, and Agent Orange (Ref. 1). Problems associated with this process include dangers of spills, difficulty of monitoring and the fact that soils are not typically treated at-sea.

Finally, coincineration involves the use of combustible wastes in boilers or other incinerators as fuels. Energy from the waste is used both to destroy waste organics and to generate energy. Disadvantages of this technology for the 93rd Street School soils include the fact that they have low fuel value and that they could potentially damage a boiler system.

2.1.3 ASSOCIATED CONTROL TECHNOLOGIES

During implementation of remedial actions at the 93rd Street School site, it may be necessary to employ temporary control technologies to minimize air pollution, surface water pollution, and direct contact risks. These temporary control technologies are described in the following paragraphs.

2.1.3.1 AIR POLLUTION CONTROLS

If soils are to be excavated during remediation of the site, it may be necessary to temporarily store these soils on-site prior to treatment, destruction, or disposal. To minimize the effects of air pollution resulting from emissions of volatiles or particulates, a number of control technologies may be employed. These technologies include construction of temporary caps and/or covers and use of dust control chemicals and/or equipment. These control technologies are described in the following paragraphs.

2.1.3.1.1 TEMPORARY CAPPING/CONTAINMENT

Procedures for placement and maintenance of long-term caps as remedial action technologies were described previously in

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this section. Short-term containment of wastes to prevent air pollution could be accomplished by covering waste piles with plastic sheeting, foam or other durable plastic or fabric; or by placing wastes inside a temporary storage container or inside a temporary storage facility. The feasibility of each of these options would depend upon the length of time for which storage was required.

2.1.3.1.2 DUST CONTROLS

Dust control technologies can be used to prevent contaminated particles from becoming airborne. Controls typically used include chemical dust suppressants, wind screens, water spraying and synthetic covers.

Chemical dust suppresants such as resins, bituminous materials and polymers can be used to temporarily strengthen the bonds between soil particles. These suppresants are typically applied from a wagon equipped with a water supply and spray system. While these technologies are typically reliable for short-term control (they can be very effective for periods up to 4 weeks (Ref. 1)), the length of time for which they are effective is affected by the frequency of soil disturbances due to heavy rains, traffic and plant growth. The primary disadvantages of this control technology are the potential for secondary contamination of soil and groundwater and modification of the waste in ways which will adversely affect its treatability or stability.

Windscreens are inexpensive screens which can be set up around an area being excavated or around a waste pile to control the wind velocity so that fewer particles become airborne. The primary drawback of these screens is that they are only partially effective in controlling inhalable sized particulate emissions.

Water spraying can be a very effective method for controlling dust emissions from waste piles, areas actively being excavated, and from uncovered containment vessels. Water must be reapplied relatively frequently to maintain effectiveness. The frequency of reapplication is controlled by factors such as humidity, temperature, and traffic level.

Finally, a number of other dust suppression techniques including maintaining proper slope and orientation of waste piles during excavation and covering waste piles with synthetic covers secured with tension cables can be used to minimize air pollution during site remediation.

2.1.3.2 SURFACE WATER CONTROLS

Surface water controls may be necessary during site remediation to prevent run-on and intercept runoff, to prevent infiltration, and to control site erosion. The technologies available for controlling surface waters include capping, regrading, revegetation, and construction of dikes/berms, channels/waterways, and terraces or benches. Capping controls were discussed previously in Section 2.1.1.2; therefore descriptions of the other surface water control technologies are presented in the following paragraphs.

2.1.3.2.1 REGRADING

Grading is typically performed in conjunction with capping activities to shape the surface of the cap so that surface water infiltration is minimized, runoff velocities are reduced, erosion is minimized, and surface soils are roughened and loosened for revegetation. Grading can be performed with conventional construction equipment. Cover materials for the 93rd Street School site could probably be obtained from a local supplier. Even if RCRA capping procedures were not going to be implemented, grading of a new soil cover could be used to significantly reduce the risk of exposure of wastes to surface water and humans and other life forms. However, long term monitoring and maintenance would have to be carefully and consistently performed to ensure that wastes did not become exposed due to erosion or begin leaching contamination into surface water runoff or groundwater.

2.1.3.2.2 REVEGETATION

Revegetation operations are typically performed following grading operations to decrease the risk of erosion caused by wind and surface water runoff and to increase the stability of surface soils. Activities typically performed in the revegetation process include selection of a suitable plant species, seed bed preparation, seeding/planting, mulching or chemical stablilzation, and fertilization and maintenance. Generally, revegetation is a relatively inexpensive method for controlling erosion. Plant species such as some forms of grasses can be selected which require very little maintenance. Over the long-term, however, some maintenance activities may be required including application of lime and/or fertilizer, replanting, and regrading.

2.1.3.2.3 DIKES AND BERMS

Dikes and berms are temporarily compacted earthen ridges or ledges constructed up-slope from or along the perimeter of contaminated areas. The primary purpose of these structures is to provide short-term protection (usually less than 1 year (Ref. 1)) of contaminated areas by intercepting and diverting runoff to drainage ways. Dikes and berms can also be used during excavation and removal operations to isolate contaminated soils temporarily stored on-site. The primary disadvantage of these structures at contaminated sites is that some of the soil may become contaminated due to contact with the waste. In addition, analysis of the soils may be required prior to removal.

2.1.3.2.4 CHANNELS AND WATERWAYS

Channels are ditches excavated at a site to collect and transfer runoff. They vary in cross section and construction. These channels can be stabilized with vegetation or rip-rap to increase design life.

Diversions are earthen channels excavated along the contours of a graded slope with a supporting earthen ridge constructed on the down slope edge of the channel.

Swales are channels with less steep side slopes and vegetation placed upon the perimeter of a site to prevent off-site runoff from entering the site or adjacent to landfills to transport surface runoff.

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Pipes constructed of corrugated metal can be cut in half and used as channels. One or more of the above surface water controls may be desirable if wastes are to remain on-site permanently or if wastes will be excavated and temporary measures will be required to divert surface water runoff from entering the site. Whatever structure is used, it must be designed with sufficient capacity, and the ability to prevent excessive velocity of flow. Maintenance of vegetated channels will be required to maintain the cover crop.

2.1.3.2.5 TERRACES AND BENCHES

These structures can be employed for long-term erosion protection on slopes of covered landfills. They would only be considered for use at the 93rd Street School site if the site were to be capped in accordance with RCRA regulations or if an on-site landfill were to be constructed.

2.1.3.3 DIRECT CONTACT CONTROLS

Direct contact controls may be necessary at the site to prevent workers and the public from coming into direct contact with contaminated soils. Workers should be given protective clothing and decontamination equipment so that they will not ingest, inhale or come into direct eye or skin contact with contaminants on their clothing or equipment. Measures to prevent non-workers from coming into direct contact with contaminated soils include keeping the school closed until remedial actions have been completed and preventing access to the site during remedial action implementation with fences, signs and/or 24 hour security.

2.2 TECHNOLOGY SCREENING

Remedial action technologies which are not technically feasible based on compatibility with site and waste characteristics, which are not consistent with the objectives of remedial action, or which are extremely difficult to implement must be eliminated prior to development of potential remedial action alternatives. Therefore, the following sections summarize site, waste, and implementation criteria which affect technology feasibility. At the end of this section, a table summarizing all technologies, their status (i.e., whether or not they will be considered further) and comments describing why certain technologies were eliminated is presented.

2.2.1 COMPATIBILITY WITH SITE CHARACTERISTICS

There are a variety of site characteristics at the 93rd Street School site which could potentially affect the technical feasibility of the remedial action technologies discussed previously. These characteristics include the volume of waste affected (7,500 cu. yd.); the site configuration including the location of the school, adjacent creeks, and adjacent properties; the relatively cold climate and moderate precipitation; the relatively low soil permeability; the relatively high soil moisture; the topography at the site; the position of the existing drainage swale; the degree of contamination; the relatively slow rate of groundwater flow; and the groundwater contours. These site characteristics were addressed in Volume I-Remedial Investigation Summary and have been mentioned throughout the descriptions of potential remedial action technologies where they were believed to have a potential impact on the technical feasibility of a particular technology.

2.2.2 COMPATIBILITY WITH WASTE CHARACTERISTICS

There are a variety of waste characteristics at the 93rd Street School Site which could potentially affect the technical feasibility of the remedial action technologies discussed previously. These characteristics include the following:

- quantity and variety of chemical contaminants
- concentrations of contaminants
- toxicity of contaminants
- solubility of wastes
- volatility of wastes
- treatability of wastes

Waste characteristics were addressed in detail in Volume I - Remedial Investigation Summary for the site. These characteristics have been mentioned throughout the descriptions of potential remedial action technologies where they had a significant impact on the determination of the technical feasibility of a particular technology.

2.2.3 OTHER TECHNOLOGY LIMITATIONS

Technologies which are in the development stages and are not anticipated to be usable for treatment of contaminated soil within a reasonable time period were eliminated.

2.2.4 CONCLUSIONS

Table 2-1 on the following pages summarizes all remedial action technologies presented in this report, the status of each technology (i.e., Eliminated, or To Be Considered) with regard to further consideration during development of preliminary alternatives, and brief explanations describing why technologies which will not be considered further were eliminated.

TABLE 2-1 SUMMARY OF RESULTS OF PRELIMINARY SCREENING OF REMEDIAL ACTION TECHNOLOGIES

REMEDIAL ACTION TECHNOLOGIES EVALUATED	STATUS	COMMENTS
I. CONTAINMENT		
A. Capping		
1. RCRA Cap	Eliminated	RCRA grade containment not necessary.
2. Non-RCRA Cap	To be Considered	
B. On-site Disposal		
1. Beneath Love-Canal Cap	Eliminated	RCRA grade containment not necessary.
2. RCRA Landfill		
a. On Love Canal Cap	Eliminated	RCRA grade containment not necessary.
b. At 93rd St. School	Eliminated	RCRA grade containment not necessary.
3. Dispose in 93rd St. School	Eliminated	Building not suitable for use as storage facility.
4. Dispose in RCRA Concrete Vault		
a. At 93rd St. School	Eliminated	RCRA grade containment not necessary.
b. Elsewhere within EDA	Eliminated	RCRA grade containment not necessary.
C. Off-site Landfill Disposal	To be Considered	
II. TREATMENT		
A. In-situ		
1. Bioreclaimation	Eliminated	Will not adequately address all site contaminants.
2. Chemical		
a. Precipitation	Eliminated	Only addresses metal contaminants.
b. Chelation	Eliminated	Only addresses metal contaminants.
c. Polymerization	Eliminated	Organic Monomers not significant problem at site.
d. Neutralization	Eliminated	Soil pH adjustment not required.
e. Hydrolysis	Eliminated	Addresses contaminants which are not significant problem at site.
f. Oxidation	Eliminated	Successful implementation extremely difficult.
g. Reduction	Eliminated	Typically used for contamination not present at site.
h. Enzymatic Degradation	Eliminated	Typically used for contamination not present at site.

TABLE 2-1 SUMMARY OF RESULTS OF PRELIMINARY SCREENING OF REMEDIAL ACTION TECHNOLOGIES (Continued)

REMEDIAL ACTION TECHNOLOGIES EVALUATED	STATUS	COMMENTS
II. TREATMENT (Continued)		
i. Permeable Treatment Beds	Eliminated	Groundwater contamination not identified.
j. Chlorination	Eliminated	Not demonstrated effective for soil treatment.
k. Catalytic Oxidation	Eliminated	Toxicity of ruthenium tetroxide limits use.
l. Chloroiodide Degradation	Eliminated	Not demonstrated effective in large scale soil cleanup.
m. Dechlorination	Eliminated	Not demonstrated effective in large scale soil cleanup.
3. Physical		
a. In-situ heating	Eliminated	Will not adequately address all site contaminants.
b. Artificial Ground Freezing	Eliminated	Temporarily isolates but does not treat wastes.
c. Vitrification		
i. In-situ	Eliminated	Groundwater table and waste depth unfavorable.
ii. Elsewhere within EDA	To Be Considered	
B. On-Site Stabilization/Solidification		
1. Cement Based Solidification	Eliminated	Will not adequately address all site contaminants.
2. Silicate Based Solidification/ Stabilization	To Be Considered	
3. Sorbent Addition	Eliminated	Will not adequately address all site contaminants.
4. Thermoplastic Solidification	To Be Considered	
5. Surface Microencapsulation	To Be Considered	
C. On-Site Thermal Treatment		
1. At 93rd St. School Site	To Be Considered	
2. At Love Canal	To Be Considered	
D. Fixed Off-Site Thermal Treatment	Eliminated	Facilities unable or unwilling to accept wastes.
III. NO ACTION	To Be Considered	

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3.0 DEVELOPMENT AND SCREENING OF PRELIMINARY REMEDIAL ACTION ALTERNATIVES

The purpose of this section is to develop a number of preliminary remedial action alternatives by combining the remedial action containment and treatment technologies which were not eliminated in the previous section. Each of these alternatives as well as a "no action" alternative will be described briefly and then evaluated in terms of their overall effectiveness in minimizing threats to human health and the environment, their technical feasibility and cost. A table is presented at the end of this section which summarizes all preliminary alternatives considered, their status regarding further consideration, and reasons for eliminating those alternatives which will not be evaluated further.

3.1 DEVELOPMENT OF PRELIMINARY ALTERNATIVES

In the following sections, preliminary alternatives are developed and evaluated in accordance with current EPA guidance.

3.1.1 THE NO ACTION ALTERNATIVE

The no action alternative would involve leaving the wastes at the 93rd Street School site undisturbed and performing periodic monitoring of the groundwater, surface water, and air as well as simple site maintenance tasks including pavement and vegetative cover maintenance. No treatment or containment technologies would be implemented unless monitoring indicated a change in site characteristics resulting in increased public health and environmental risks.

3.1.2 CONTAINMENT ALTERNATIVES

Containment technologies which passed preliminary screening include construction of a low permeability cover on-site, and removal ofhot spot soils followed by disposal at an off-site RCRA landfill. Preliminary containment alternatives developed from these technologies are described in the following paragraphs.

3.1.2.1 LOW PERMEABILITY COVER

Placement of a low permeability cover at the site would be conducted to minimize direct contact risks associated with all identified contaminated soils at the site. It is anticipated that the cover would have to cover a maximum area of approximately eight acres. Placement of the cover might require that retaining walls be built along the edges of the paved areas and that the existing parking lots overlying contaminated soils be repaved. A number of special considerations might have to be included if this alternative were implemented since there might be a substantial increase in the elevation of the covered area. This increase would make it necessary to raise the existing monitoring wells and possibly to provide stairways for access to the covered area. In addition, covering of the wastes on-site would require that the site be inspected every six months, that the groundwater be monitored on a quarterly basis, and that the cover, paved areas, and monitoring wells be maintained properly. Finally, every five years, a detailed assessment of the effectiveness of the cover would have to be performed.

3.1.2.2 OFF-SITE RCRA LANDFILL DISPOSAL

Disposal of hot spot soils at an off-site RCRA landfill would involve excavation of the hot spot site soils followed by transportation of these soils to an approved off-site RCRA landfill. Following excavation, clean fill would be placed in the excavated areas, and then a low permeability cover would be placed at the site. Long-term maintenance and monitoring requirements would be similar to those described previously for the low permeability cover alternative except monitoring requirements might be reduced since hot spot soils would no longer be present at the site. It should be noted that one potentially limiting factor for this alternative is the fact that prior to disposal at the off-site RCRA landfill, it would have to be demonstrated that the hot spot soils could pass the dioxin TCLP test. Without prior treatment, it is possible that they would fail the TCLP test and, therefore, land disposal of these soils after November 8, 1988 would not be allowed.

3.1.3 TREATMENT ALTERNATIVES

Treatment technologies which passed preliminary screening include solidification/stabilization (either silicate based, thermoplastic or surface microencapsulation), on-site thermal treatment, thermal treatment at Love Canal and vitrification within the EDA. Treatment alternatives developed from these technologies are described in the following paragraphs.

3.1.3.1 SOLIDIFICATION/STABILIZATION

Solidification/stabilization of contaminated site soils would involve excavation of hot spot soils followed by solidification/ stabilization on-site. Following treatment, samples of the treated soils would be collected and analyzed to verify that they could either be delisted or meet hybrid closure requirements prior to disposal. Then the treated wastes would be placed in the excavated areas, and a low permeability cover would be placed over the entire site. Long-term maintenance and monitoring requirements would be similar to those described previously for the low permeability cover alternative except monitoring requirements might somewhat reduced since hot spot soils would be rendered less toxic or non-toxic during treatment.

3.1.3.2 ON-SITE THERMAL TREATMENT

On-site thermal treatment would involve procuring a mobile thermal treatment unit capable of destroying soil organics and vaporizing or stablizing soil inorganics. Initial steps involved in implementation of this alternative would include excavating the hot spot soils, thermally treating these soils, and determining the status of the residual ash and other thermal treatment byproducts as hazardous, delistable, or capable of meeting hybrid closure requirements. If the byproducts were determined to be hazardous, they could be handled in one of the following ways:

- CASE I: Transport byproducts to off-site RCRA landfill for disposal/Refill excavated area/Place low permeability cover over site/Monitor and maintain site as described previously in Section 3.1.2.2.
- CASE II: Solidify/Stabilize byproducts on-site/Deposit treated byproducts on-site/Place low permeability cover over site/Monitor and maintain site as described in Section 3.1.3.1.

If the byproducts were found to be delistable or capable of meeting hybrid closure requirements, however, they would be handled as follows:

- CASE III: Redeposit the byproducts on-site/Place low permeability cover over site/Monitor and maintain site as described previously in Section 3.1.3.1.

3.1.3.3 THERMAL TREATMENT AT LOVE CANAL

EPA has proposed that creek and sewer sediments from the vicinity of Love Canal be treated via a mobile thermal treatment unit at Love Canal. This unit could also be used to treat soils from the 93rd Street School site. Thermal treatment at Love Canal would involve the same steps as on-site thermal treatment. However, transportation of the hot spot soils to the thermal treatment facility and transportation of the treated byproducts either back to the 93rd Street School site or to an off-site RCRA landfill would also be required.

3.1.3.4 VITRIFICATION WITHIN EDA

Vitrification within the EDA would involve procuring an approved off-site location, excavating trenches at that location, then excavating the hot spot soils at the 93rd Street School site, transporting these soils to the off-site location, depositing them in the trenches, covering the soils with clean fill and vitrifying. At the school site, it would be necessary to refill the excavated areas and then to place a low permeability cover at the site. Long-term maintenance and monitoring requirements at the 93rd Street School site would be similar to those described previously in Section 3.1.2.2. In addition, long-term monitoring might be required at the vitrification site if analysis in the vicinity of the vitrified waste indicates that unacceptable levels of contaminants are still present in soils, groundwater, or surface water.

3.2 PRELIMINARY ALTERNATIVES SCREENING

In this section, preliminary alternatives are screened to eliminate those alternatives which will not provide adequate protection of public health or the environment as well as those which are significantly more expensive but which do not provide significantly better protection of the public health and the environment. Following this screening, the remaining final alternatives will be analyzed in greater detail in Section 4.

3.2.1 ENVIRONMENTAL AND PUBLIC HEALTH SCREENING

The effectiveness of each of the preliminary remedial action alternatives in protecting human health and the environment is assessed in the following sections. Following these assessments, alternatives which are determined to have significant adverse impacts in comparison to other similar alternatives or which will not adequately protect human health and the environment are eliminated from further consideration.

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As determined previously in Section 6 of Volume I - Remedial Investigation Summary, the primary source of concern at the 93rd Street School site is the presence of contaminants in the hot spot area soils and other contaminated soils in the vicinity of the historic swale which pose a direct contact risk by the following exposure pathways:

(1) Dust (i.e., fugitive particles) may be carried into the air from the ground surface

(2) Direct contact between contaminated soils and humans or other life forms may occur

Additional exposure pathways which are of lesser concern include emission of volatiles and transport of contaminated particulates in surface water at the site.

The potential receptors who could be affected by the contaminated soils, estimates of the exposure point concentrations to which these receptors might be exposed, and the potential impacts of these exposures on the receptors were discussed previously in Section 6 of Volume I - Remedial Investigation Summary. It was concluded that the potential receptors at greatest risk of exposure to site contaminants would be children who might play at the school site which is not secured to prevent direct contact. As a result of direct contact with site soils over long periods of time, it is possible that significant health risks could develop.

Assessments of the effectiveness of each of the preliminary alternatives in preventing adverse impacts on the environment and human health are presented in the following sections.

3.2.1.1 AIR QUALITY

Air quality at the site was evaluated during the remedial investigation by Phoenix Safety Associates, Ltd. (PSA) to ensure worker safety during site sampling. A review of the daily logs kept by PSA during sampling revealed that throughout drilling operations and well development, no significant levels of volatile contaminants above background levels were detected in the breathing zone of the workers. In addition, even directly above the borings and monitoring wells, readings did not typically exceed background levels by more than 2 ppm. It must be noted, however, that in a few cases when borings were first drilled and when well caps were first removed, readings as high as 10 ppm above background levels were detected. These relatively high readings were found directly above the borings and wells, and they dropped rapidly (i.e., within one to two minutes) as vapors dissipated. It is believed that these volatiles originated in the contaminated soils since the groundwaters at the site were found to be free of high levels of volatile contaminants. In conclusion, the results of air monitoring indicated that if site soils remain in place and undisturbed, the short-term risk of volatile emissions will be virtually negligible. In addition, even if the soils are disturbed due to erosion or excavation, it was asserted in the risk assessment that risks due to volatile emissions would be insignificant in comparison to particulate emission or direct contact risks.

Particulate emissions could pose a threat to persons who might inhale the contaminated dust or ingest contaminated dust from dirty hands, foods, or other sources if the site were disturbed due to erosion or excavation.

It is anticipated that if the no-action alternative were implemented, it would not be effective in preventing short-term particulate emissions released by wind erosion. In addition, the effectiveness of this alternative in preventing particulate emissions might decrease with time due to the effects of erosion.

An alternative which would provide greater short-term protection against particulate releases is placement of a low permeability cover. During implementation of this alternative, the soil would remain undisturbed (i.e., no excavation would be required); thus short-term volatile and particulate emissions would be minimal. Once in-place, the cover would serve as a very effective long-term barrier for preventing releases of particulates from underlying contaminated soils.

All other alternatives involve excavation of hot spot soils. During excavation, the short-term risk of volatiles emissions would increase, and site monitoring would be required to confirm that volatiles were not present at levels that would make respiratory protection for workers necessary. Because any volatile emissions would be expected to dissipate rapidly, however, effects off-site would be negligible. In addition, the dust control measures described previously in Section 2 should be used to effectively reduce potential emissions of contaminated particulates if excavation is performed to minimize risks associated with inhalation or ingestion of contaminated dust.

Off-site landfilling of the hot spot soils would impose risks associated with excavation as well as risks of short-term off-site exposures during transport of the hot spot soils to the RCRA landfill and during disposal of these soils at the landfill. Once the hot spot soils were removed, however, the long-term exposure risk at the 93rd Street School site would be decreased since the hot spot soils would no longer be present at the site.

Solidification/stabilization of the hot spot soils would impose risks associated with excavation as well as risks during handling of the soils on-site during treatment. Air pollution controls should be used during handling and treatment to minimize these risks. Long-term risks of air emissions would be much lower than those posed by the no action alternative since the hot spot soils would be treated, and the treated soils and other contaminated soils would be covered with a low permeability cover. However,

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periodic inspection of the site would be necessary to ensure that erosion resulting in dispersion of contaminated dust did not develop.

The on-site thermal treatment alternative would pose the greatest short-term exposure risks to workers at the site and possibly to nearby residents since, in addition to excavation related air releases, air releases could potentially occur during feed preparation operations such as soil drying or pulverizing and during release of off-gases potentially contaminated with hazardous decomposition products and metal fumes. It should be noted that if a thermal treatment system is selected, it should be demonstrated effective in preventing air emissions. The most desirable thermal treatment units would not require feed preparation, would generate fewer toxic decomposition products and/or metal fumes, or would be equipped with highly effective emission control systems. Additional short-term risks of this alternative would depend upon whether or not the byproducts were found to be hazardous. If the byproducts were found to be hazardous and were then transported and disposed at a RCRA landfill (Case I), there would be an increased short-term risk of particulate emissions during transport and disposal of the ash. If the ash was found to be hazardous and was then solidified/stabilized and redeposited on-site (Case II), there would be an increased short-term risk of particulate emissions during solidification/ stabilization. Finally, if the byproducts were found to be delistable or capable of meeting hybrid closure requirements and were then reburied at the site (Case III), particulate emissions during disposal would not pose a significant hazard to site workers or nearby populations. The long-term effectiveness of Cases I to III for this alternative in preventing air related exposures are therefore anticipated to be as follows:

- CASE I - The long-term effectiveness would be similar to that of off-site disposal of the untreated hot spot soils at a RCRA landfill except that the risk of potential volatile emissions during transportation of byproducts and at the off-site landfill would be reduced.

- CASE II - The long-term effectiveness would be similar to that of solidification/stabilization except that the potential future risks of volatile or particulate emissions from hot spot soils would be reduced.

- CASE III - The long-term effectiveness would be relatively good since the hot spot soils would no longer contain significant levels of hazardous volatile or particulate contaminants, and untreated contaminated soils would be capped.

The thermal treatment at Love Canal alternative would pose somewhat reduced short-term risks at the 93rd Street School site since any emissions during feed preparation operations or during release of off-gases would occur off-site. Additional short-term risks, however, might be imposed on residents of houses on the route between the site and the thermal treatment facility and on residents of houses near the thermal treatment facility. The long-term effectiveness for each of the three cases (i.e., Cases I, II and III) of off-site thermal treatment would be essentially the same as those described previously for on-site thermal treatment.

Vitrification within the EDA of the contaminated soils would require that the soils be excavated and transported to a suitable off-site location. Short-term air pollution risks would include risks associated with hot spot soil excavation; potential exposure of people living along the route between the school site and the vitrification site; and potential exposures at the vitrification site during burial of the contaminated soil and during vitrification. The temperatures at which the soil would be vitrified would be greater than the boiling points of both the metals and organics of concern. Therefore, metal as well as organic vapors could potentially filter up through the overlying soils during vitrification. Vapors reaching the atmosphere would have to be carefully collected and treated in the off gas collection hood and treatment system. In addition, the overlying soils would have to be tested to determine if hazardous levels of metal vapor were deposited in these soils during vitrification which could eventually be released to the atmosphere due to wind erosion. If the overlying soils were determined to be hazardous and removal was deemed necessary, further airborne particulate exposures could occur during excavation and transport of contaminated overlying soils to an off-site hazardous waste landfill or treatment facility. The long-term effectiveness of this alternative in preventing air pollution at the off-site location would depend upon whether or not overlying soils were rendered hazardous during vitrification. The long-term effectiveness at the school site, however, would be similar to that of the off-site landfill disposal alternative since there would no longer be any hot spot soils at the site.

3.2.1.2 SURFACE WATER QUALITY

As described previously, based on the current results of the remedial investigation of the 93rd Street School site, the groundwater and surface water (i.e., the water in the existing swale) do not appear to be contaminated with significant levels of any of the parameters of concern. Thus it is likely that contaminants in site soils are not leaching readily into waters at the site, and it is not anticipated that leaching will occur in the near future providing that the soils remain undisturbed. This will be verified during the sampling and analysis of groundwater to be performed during the remedial design phase. It is possible, however, that although significant surface water contamination has not been identified, contaminated particulates could be carried off-site into Bergholtz Creek via surface water runoff. Therefore, precautions should be taken to prevent direct contact between contaminated surface soils and runoff.

The no action alternative would be ineffective for preventing either short or long-term risks of surface water erosion. Placement of a low permeability cover over the contaminated soils, however, would reduce both the short and long-term risks of particulate migration via surface water for the following reasons:

- Surface water runoff would no longer be in direct contact with contaminated surface soils since vegetated, compacted, clean soil would separate the contaminated former surface soils from the new site surface.
- The elevation of the majority of the site would be raised thus reducing the possibility of floodwaters carrying away contaminated soils.

Other alternatives would be somewhat less effective on a short-term basis than the low permeability cover in preventing migration of contaminated particulates in surface waters because of excavation activities. To minimize these short-term risks, many of the surface water control technologies discussed previously could be used to reduce run-on and to control runoff during excavation.

The long-term effectiveness of almost all of these alternatives is anticipated to be very good for the following reasons:

- Off-Site Landfilling would result in reducing the risk of surface water contamination at the 93rd Street School site since the hot spot soils would no longer be present at the site.
- Solidification/Stabilization would result in effective immobilization of hot spot soils at the site and would therefore result in reduced long-term exposure risks.
- On-Site Thermal Treatment and Thermal Treatment at Love Canal
- Case I would result in reducing the risk of surface water contamination at the 93rd Street School site since the hot spot soils would no longer be present at the site
- Case II would result in approximately the same long-term effectiveness as the solidification/stabilization alternative.

- Case III would result in reducing the risk of surface water contamination at the 93rd Street School site since the hot spot soils would be rendered delistable or appropriate for hybrid closure.
- Vitrification Within the EDA would result in reducing the risk of surface water contamination at the 93rd Street School site, since the hot spot soils would no longer be present. At the vitrification site, however, if surface soils were rendered hazardous and not taken to an off-site landfill or covered, surface water contamination could potentially occur.

3.2.1.3 DIRECT CONTACT RISKS

Direct contact with the contaminants at the 93rd Street School site would result in the greatest threat to human health. As described previously, some of the contaminants identified in site soils during the remedial investigation are known or suspected carcinogens or are otherwise toxic to humans. These contaminants may enter the human body by primary routes including ingestion or inhalation, or by a variety of other routes. Detailed descriptions of the potential toxic effects of the soil contaminants and the potential routes of exposure to these contaminants were presented in Section 6 of Volume I - Remedial Investigation Summary. These descriptions indicated that the remedial action alternative selected should be effective in minimizing the risk of direct contact between humans and contaminated site soils with elevated levels of dioxin, PAHs, and arsenic.

The no action alternative poses a relatively high risk of direct contact exposure even though the school is not in operation since the site is not secured to prevent public access, and contaminants were identified in surface soils. If local children were to play at the abandoned school site, they would be at an increased risk of potentially harmful direct contact exposures because they might dig in the soil on the school grounds, play in a manner that would generate dust, generate heavy traffic on the vegetation thereby decreasing its viability, and neglect washing their hands increasing the risk of ingestion of contaminants. If the no action alternative were implemented and the school was allowed to reopen, the risk of direct contact exposures would be even greater.

Covering the site with a low permeability cover would greatly reduce both the short and long-term risks of direct contact exposures even if the school were reopened since the contaminated soils would be covered with vegetated, compacted clean soil designed for long-term waste containment.

All other alternatives would involve excavation of hot spot soils which would increase the short-term direct contact exposure risks for both workers on the site and potentially for any other persons entering the site. Protective clothing, safety and decontamination equipment should be used to reduce direct contact risks for site workers. Unauthorized persons should be kept off-site during excavation to prevent them from coming into direct contact with contaminated soils. Short-term risks of direct contact exposures would be greater for those alternatives which would require more extensive handling and transportation of untreated or partially treated soils from the site.

The long-term effectiveness of each of these other alternatives in preventing direct contact exposures would be very similar to their effectiveness in preventing surface water contamination as described in the previous section.

3.2.1.4 CONCLUSIONS

The no action alternative would not be effective for preventing short-term risks of particulate emissions to the air, to the surface water, or direct contact risks. In addition, it has been determined that these risks may increase with time due to wind and surface water erosion and with the potential reopening of the school. Therefore, this alternative is not capable of adequately protecting human health and the environment. However, since EPA guidance recommends that the no action alternative be evaluated throughout the feasibility study, it will not be eliminated at this time.

Of the two preliminary containment alternatives, the low permeability cover alternative has been determined to be the most effective alternative for preventing short-term air, surface water and direct contact exposure risks. Because the off-site landfilling alternative requires excavation of hot spot soils and off-site landfilling of these soils, this alternative poses a greater short-term risk of emissions to the air and surface water and of direct contact.

The long-term effectiveness of the off-site RCRA landfill disposal alternative in minimizing exposure risks at the site would be better than that of the low permeability cover alternative since the hot spot soils would no longer be present at the site. In conclusion, of the two preliminary containment alternatives considered, the low permeability cover alternative is more effective for protecting the public health and the environment on a short-term basis. On a long-term basis, however, off-site RCRA landfill disposal might be more effective.

Of the four preliminary treatment alternatives, it has been determined that solidification/stabilization would pose the least risk of short-term exposures since it does not involve thermal treatment. The greatest short-term risks of exposure at the 93rd Street School site would be posed by the on-site thermal treatment alternative; however, the greatest overall risks would result if the vitrification within the EDA alternative were selected. This alternative would result in potential emissions and direct contact risks during excavation at the 93rd Street School site, transportation of the untreated soils to the vitrification site , drying of the soils, reburial of the untreated soils, and vitrification. Even following treatment, potential impacts could occur if the soils overlying the vitrified wastes were found to contain elevated levels of contaminants. It is concluded, therefore, that vitrification of the soils would be the least effective of the preliminary treatment alternatives considered in protecting human health and the environment. In addition, the final product following vitrification might not justify the additional risks. Therefore, vitrification within the EDA will be eliminated from further consideration at this time.

In conclusion, the following preliminary remedial action alternatives will be considered further:

- No Action
- Low Permeability Cover
- Off-Site RCRA Landfill
- Solidification/Stabilization
- On-Site Thermal Treatment (Cases I, II, and III)
- Thermal Treatment at Love Canal (Cases I, II, and III)

3.2.2 ORDER OF MAGNITUDE COST COMPARISON

EPA guidance as described in the document entitled "Guidance on Feasibility Studies Under CERCLA", June 1985 requires that preliminary remedial action alternatives be evaluated on the basis of cost. The purpose of this evaluation is to eliminate those alternatives which have costs an order of magnitude greater than those of other similar alternatives but which do not provide greater environmental or public health benefits or greater reliability. Because this evaluation is only a preliminary screening tool, it is recommended by the guidance that costs be estimated to a level of accuracy within -50 to +100 percent of true costs. Following preparation of a cost estimate for each alternative, the alternatives can then be subjected to a present worth analysis to determine if any are an order of magnitude more expensive than the others. In the following sections, the cost estimates for preliminary alternatives, results of present worth analysis, and conclusions based on the order of magnitude cost comparison are presented.

3.2.2.1 COST ESTIMATES

Cost estimates for each of the preliminary alternatives have been prepared based upon readily available cost data presented in EPA publications, Mean's Building Construction Cost Data, and other sources identified during the screening of remedial action technologies. A complete list of the references used during preparation of cost estimates is presented in Appendix A. It should be noted that where 1988 costs were not available, the Implicit Price Deflators of the Gross National Product (GNP) were used to adjust cost data accordingly. A summary of these Implicit Price Deflators for 1981 through 1987 is presented in Table 3-1. Because an Implicit Price Deflator Multiplier Value for 1988 will not be available until January 30, 1989, an estimated multiplier of 1.03 was used.

Cost estimates for each of the following preliminary remedial action alternatives are presented in Tables 3-2 to 3-7, respectively:

- No Action
- Low Permeability Cover
- Off-Site RCRA Landfill
- Solidification/Stabilization
- On-Site Thermal Treatment (Cases I to III)
- Thermal Treatment at Love Canal (Cases I to III)

Descriptions of how these cost estimates were developed are presented in the following paragraphs. It should be noted that all costs presented in this Section were rounded off to the nearest $25,000.

Table 3-2 presents the cost estimates for the no-action alternative. It should be noted that there will be no capital expenses associated with this alternative. Periodic expenses that will be associated with the no action alternative will include environmental monitoring for surface water, groundwater and air quality; general site maintenance including pavement repair and lawn care; and a detailed five year evaluation of alternative performance. These expenses were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a total estimated annual cost of $250,000 for the no action alternative.

TABLE 3-1 - IMPLICIT PRICE DEFLATORS OF THE GNP

TO CONVERT	TO	MULTIPLY BY
1981 Dollars	1982 Dollars	1.09
1982 Dollars	1983 Dollars	1.06
1983 Dollars	1984 Dollars	1.04
1984 Dollars	1985 Dollars	1.04
1985 Dollars	1986 Dollars	1.03
1986 Dollars	1987 Dollars	1.03
1987 Dollars	1988 Dollars	1.03*

* The official value for this multiplier will not be available until January 30, 1989. For the purposes of this study, however, an estimate of 1.03 was used.

TABLE 3-2 - PRELIMINARY COST ESTIMATE FOR THE NO ACTION ALTERNATIVE

CAPITAL EXPENSE ITEMS		COST
1. None		$0
PERIODIC EXPENSE ITEMS		**COST/YR**
1. Environmental Monitoring		$150,000
2. Site Maintenance		$25,000
3. Detailed Evaluation (every 5 years)		$25,000
	Sub Total:	$200,000
	20% Eng. and Reg. Contingency:	$50,000
	TOTAL:	$250,000

Table 3-3 presents the capital and annual cost estimates for the low permeability cover alternative. Capital expenses associated with this alternative will include purchase, transport, spreading and compaction of the required cover layers; hydroseeding, lime spreading and fertilizing; repair and reinforcement of paved areas; raising of existing monitoring wells and other miscellaneous site modifications and final survey. Periodic expenses include semi-annual site inspections; quarterly groundwater monitoring; detailed five year evaluations of cap performance; and site maintenance including pavement repair, cover repair, monitoring well repair, and other maintenance tasks. Both the capital and annual estimated costs were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $1,325,000 for the capital cost and $225,000 for the annual cost of the low permeability cover alternative.

Table 3-4 presents the capital and annual cost estimates for the off-site RCRA landfill disposal alternative. Capital costs associated with this alternative will include excavation, transport and disposal of 7,500 c.y. of hot spot soils at a RCRA landfill; purchase, transport, and placement of 7,500 c.y. of clean fill; reconstruction of paved areas and placement of a low permeability cover. It should be noted that costs of $4.00 per loaded mile (assuming 375 20 c.y. truck loads travelling a distance of 500 miles) and $90.00 per ton were used for transportation and off-site disposal of hazardous soils. Annual expenses will be the same as those described for the low permeability cover alternative except monitoring costs may be somewhat lower. The capital and annual estimated costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a total estimated capital cost of $3,750,000 and a total estimated annual cost of $150,000 for the off-site RCRA landfill disposal alternative.

TABLE 3-3 - PRELIMINARY COST ESTIMATE FOR THE LOW PERMEABILITY COVER ALTERNATIVE

CAPITAL EXPENSE ITEMS	COST
1. Purchase, transport, and placement of cover layers	$800,000
2. Hydroseeding, Lime Spreading and Fertilizing	25,000
3. Repair and Reinforcement of Paved Areas	50,000
4. Raising of existing monitoring wells & misc. activities	200,000
5. Final Survey	25,000
Sub Total:	$1,100,000
20% Eng. and Reg. Contingency	225,000
TOTAL:	$1,325,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Site Inspection (semi-annual) and Maintenance	$25,000
2. Groundwater Monitoring (quarterly)	125,000
3. Detailed Evaluation (every 5 years)	25,000
Sub Total:	$175,000
20% Eng. and Reg. Contingency:	50,000
TOTAL:	$225,000

TABLE 3-4 - PRELIMINARY COST ESTIMATE FOR THE OFF-SITE RCRA LANDFILL DISPOSAL ALTERNATIVE

CAPITAL EXPENSE ITEMS	COST
1. Excavation of Hot Spot Soils and Overlying Pavement	$ 75,000
2. Transport of Hot Spot Soils	750,000
3. Disposal of Hot Spot Soils	1,025,000
4. Purchase, Transport and Placement of Clean Soils	125,000
5. Construction of Low Permeability Cover	1,100,000
6. Reconstruction of Paved Areas	50,000
Sub Total:	$3,125,000
20% Eng. and Reg. Contingency:	625,000
TOTAL:	$3,750,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Site Inspection (semi-annual) and Maintenance	$25,000
2. Groundwater Monitoring (quarterly)	75,000
3. Detailed Evaluation (every 5 years)	25,000
Sub Total:	$125,000
20% Eng. and Reg. Contingency:	25,000
TOTAL:	$150,000

Table 3-5 presents the capital and periodic cost estimates for the solidification/stabilization alternative. Capital costs associated with this alternative include preliminary testing and approvals; excavation of 7,500 c.y. ofhot spot soils and pavement above these soils; solidification/stabilization of these soils; a sampling and analysis program to verify that treated soils can be placed beneath a low permeability cover; disposal of the treated hot spot soils on-site; placement of a low permeability cover; and reconstruction of paved areas. It should be noted that a cost range of $50/ton to $150/ton and a weight of 11,250 tons (assuming the weight of soils from the site is 1.5 tons per c.y.) was used to determine the 1988 cost for solidification/ stabilization. Periodic expenses are the same as those described for the low permeability cover alternative except for the fact that monitoring costs may be somewhat lower. Both the capital and annual estimated costs were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $2,375,000 to $3,775,000 for the capital cost and $150,000 for the annual cost of the solidification/stabilization alternative.

Table 3-6 presents the capital and annual cost estimates for the on-site thermal treatment alternative. Variations in the cost estimates for this alternative will occur depending upon whether the byproducts are handled as a hazardous waste and disposed off-site (Case I), are solidified/ stabilized and then disposed on-site (Case II), or are determined to be delistable or capable of meeting hybrid closure requirements and are disposed on-site (Case III). Costs for each of these three cases are presented individually.

The capital costs associated with Case I include preliminary testing and approvals; excavation of approximately 7,500 c.y. of hot spot soils and the pavement above the soils; thermal treatment of the soils; costs for thermal treatment unit mobilization/demobilization; thermal

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TABLE 3-5 - PRELIMINARY COST ESTIMATE FOR THE SOLIDIFICATION/STABILIZATION ALTERNATIVE

CAPITAL EXPENSE ITEMS	COST
1. Preliminary Testing and Approvals	$ 100,000
2. Excavation of Hot Spot Soils and Pavement	75,000
3. Solidification/Stabilization of Hot Spot Soils	575,000 to 1,700,000
4. Sampling and Analysis of Treated Soils	25,000
5. Redisposal of Solidified/Stabilized Soils	50,000 to 75,000
6. Placement of a Low Permeability Cover	1,100,000
7. Reconstruction of Paved Areas	50,000
Sub Total:	$1,975,000 to 3,125,000
20% Eng. and Reg. Contingency	400,000 to 650,000
TOTAL:	$2,375,000 to 3,775,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as Off-Site RCRA Landfill Disposal Alternative	$150,000

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TABLE 3-6 - PRELIMINARY COST ESTIMATE FOR THE ON-SITE THERMAL TREATMENT ALTERNATIVE

CASE I:

CAPITAL EXPENSE ITEMS	COST
1. Preliminary Testing and Approvals	$ 500,000
2. Hot Spot Soil and Pavement Excavation	75,000
3. Mobilization/Demobilization of Mobile Treatment Unit and Misc. Expenses	1,000,000
4. Thermal Treatment	3,750,000
5. Sampling/Analysis of Byproducts	25,000
6. Transport Byproducts to Off-Site Hazardous Waste Landfill	750,000
7. Dispose Byproducts at Off-Site Hazardous Waste Landfill	1,025,000
8. Purchase, Transport and Place Clean Fill at Site	125,000
9. Placement of Low Permeability Cover	1,100,000
10. Reconstruction of Paved Areas	50,000
Sub Total:	$8,400,000
20% Eng. and Reg. Contingency:	$1,700,000
TOTAL:	$10,100,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as for Off-Site RCRA Landfill Disposal	$150,000

CASE II:

CAPITAL EXPENSE ITEMS	
1. Items 1,2,5,9,10 Same as Case I	$1,750,000
2. Mobilization/Demobilization of Mobile Treatment Unit	1,000,000
3. Thermal Treatment	3,750,000
4. Dispose of Byproducts on Site	50,000 to 75,000
5. Solidification/Stabilization and Associated Activities (including Preliminary Testing and Approvals and Sampling and Analysis of Treated Soils)	700,000 to 1,825,000
Sub Total:	$7,250,000 to 8,400,000
20% Eng. and Reg. Contingency:	1,450,000 to 1,700,000
TOTAL:	$8,700,000 to $10,100,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as Solidification/Stabilization	$150,000

TABLE 3-6 - PRELIMINARY COST ESTIMATE FOR THE ON-SITE THERMAL TREATMENT ALTERNATIVE (Cont'd)

CASE III:

CAPITAL EXPENSE ITEMS	COST
1. Items 1,2,5,9,10 Same as Case I	$1,750,000
2. Mobilization/Demobilization of Mobile Treatment Unit	1,000,000
3. Thermal Treatment	3,750,000
4. Dispose Byproducts on Site	50,000
Sub Total:	$6,550,000
Eng. and Reg. Contingency:	1,325,000
TOTAL:	$7,875,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as Solidification/Stabilization	$150,000

treatment; a sampling and analysis program to determine whether residual ash and other thermal treatment by-products are hazardous; transport and disposal of approximately 7,500 c.y. of by-products to a RCRA landfill; purchase, transport and placement of 7,500 c.y. of clean fill at the site; construction of a low permeability cover and reconstruction of paved areas. It should be noted that a cost of $500.00 per cubic yard of soil was used for the cost of mobile unit thermal treatment; and costs of $4.00 per loaded mile (assuming 375 20 c.y. truck loads traveling a distance of 500 miles) and $90 per ton were used for transportation and off-site disposal of hazardous residuals. Annual expenses for this alternative would be the same as those described for the off-site RCRA landfill disposal alternative. The capital and annual estimated costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $10,100,000 for the capital cost and $150,000 for the annual cost of the on-site thermal treatment (Case I) alternative.

The capital costs associated with Case II include preliminary testing and approvals; excavation of approximately 7,500 c.y. of hot spot soils and the pavement above the soils; thermal treatment of the soils; costs for thermal treatment unit mobilization/ demobilization; thermal treatment; a sampling and analysis program to determine whether the residual ash and other thermal treatment by-products are hazardous; solidification/ stabilization of byproducts (including preliminary testing and approvals and testing of treated byproducts); redisposal of the treatment by-products on-site; placement of a low permeability cover and reconstruction of paved areas. Periodic expenses will be essentially the same as those described previously for the solidification/stabilization alternative. The estimated capital and annual costs associated with this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of

$8,700,000 to $10,100,000 for the capital cost and $150,000 for the annual cost of the on-site thermal treatment alternative (Case II).

The capital costs associated with Case III include preliminary testing and approvals; excavation of 7,500 c.y. of hot spot soils and the pavement above the soils; thermal treatment of the soils; costs for thermal treatment unit mobilization/demobilization; a sampling and analysis program to verify that the residual ash and by-products are delistable or capable of meeting hybrid closure requirements; redisposal of the thermal treatment by-products on-site; placement of a low permeability cover and reconstruction of paved areas. Annual expenses associated with this alternative would be similar to those of the solidification/stabilization alternative. The estimated capital and annual costs associated with this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $7,875,000 for the capital cost and $150,000 for the annual cost of on-site thermal treatment (Case III).

Finally, Table 3-7 presents the capital and annual cost estimates for the thermal treatment at Love Canal alternative. As for the on-site thermal treatment alternative described previously, variations in cost will occur depending on how the treatment byproducts are disposed (i.e., via Case I, II or III). Costs for each of the three cases are presented individually.

The capital expense items associated with thermal treatment at Love Canal (Case I) are identical to those for on-site thermal treatment (Case I) with the exception of the additional costs of transport of the untreated soils to Love Canal and the subtraction of mobilization/ demobilization costs of the thermal unit. Annual costs for this alternative

TABLE 3-7 - PRELIMINARY COST ESTIMATE FOR THE THERMAL TREATMENT AT LOVE CANAL ALTERNATIVE

CASE I:

CAPITAL EXPENSE ITEMS	COST
1. Same as On-Site Case I ----See Table 3-6-------------- Items 1,2,5-10	$3,650,000
2. Thermal Treatment (Including Transportation of Soil to Off-Site Treatment Unit)	3,775,000
Sub Total:	$7,425,000
20% Eng. and Reg. Contingency:	1,500,000
TOTAL:	$8,925,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as On-Site Thermal Treatment Case I	$150,000

CASE II:

CAPITAL EXPENSE ITEMS	COST
1. Same as On-Site Case II ----See Table 3-6------------- Items 1, 4, 5	$2,500,000 to 3,650,000
2. Thermal Treatment (Including Transportation of Soil to Off-Site Treatment)	3,775,000
3. Transport Byproducts Back to Site	25,000
Sub Total:	$6,300,000 to $7,450,000
20% Eng. and Reg. Contingency:	1,275,000 to 1,500,000
TOTAL:	$7,575,000 to 8,950,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as On-Site Thermal Treatment Case II	$150,000

TABLE 3-7 - PRELIMINARY COST ESTIMATE FOR THE THERMAL TREATMENT AT LOVE CANAL ALTERNATIVE(Cont'd)

CASE III:

CAPITAL EXPENSE ITEMS	COST
1. Same as On-Site Case III -----See Table 3-6------------ Items 1,4	$1,800,000
2. Thermal Treatment (Including Transportation of Soil to Off-Site Treatment Unit)	3,775,000
3. Transport Byproducts Back to Site	25,000
Sub Total:	$5,600,000
20% Eng. and Reg. Contingency:	1,125,000
TOTAL:	$6,725,000

PERIODIC EXPENSE ITEMS	COST/YR.
1. Same as On-Site Thermal Treatment----See Table 3-6------ Case III	$150,000

alternative would be the same as for on-site thermal treatment (Case I). The estimated capital and annual costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $8,925,000 for the capital cost and $150,000 for the annual cost of the off-site thermal treatment alternative (Case I).

The capital costs associated with Case II are identical to those for on-site thermal treatment (Case II) with the exception of the additional costs of transportation of the untreated soils to the Love Canal thermal treatment facility, additional costs of transport of the by-products back to the 93rd Street School site and the subtraction of the mobilization/demobilization costs of the thermal unit. The annual costs for this alternative would be the same as those for on-site thermal treatment (Case II). Thus the estimated capital and annual costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $7,575,000 to $8,950,000 for the capital cost and $150,000 for the annual cost of the thermal treatment at Love Canal alternative (Case II).

Finally, capital costs associated with Case III are identical to those for on-site thermal treatment (Case III) with the exception of the additional costs of transportation of the untreated soils to the Love Canal thermal treatment facility, transportion of the non-hazardous ash and other by-products back to the 93rd Street School site and the subtraction of unincurred mobilization/demobilization costs of the thermal unit. Annual expenses associated with this alternative will be the same as for the on-site thermal treatment alternative (Case III). The estimated capital and annual costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of

$6,725,000 for the capital cost and $150,000 for the annual cost of the thermal treatment at Love Canal alternative (Case III).

3.2.2.2 PRESENT WORTH ANALYSIS

EPA guidance requires that a present worth analysis be performed to evaluate expenditures which occur over different time periods by reducing all future costs to their present worth. This makes it possible to compare the costs of remedial action alternatives on the basis of a single monetary figure representing the amount of money which, if invested at the present time and used as needed, would be sufficient to cover all of the costs associated with a particular remedial action alternative over its planned life. EPA guidance recommends that a discount rate of 10 percent (before taxes and after inflation) should be assumed, and that the time period of performance over which alternatives are evaluated should not exceed 30 years. Thus, the preliminary alternatives for the 93rd Street School site were evaluated based on a discount rate of 10 percent and a performance period of 25 years. Results of this present worth analysis as well as estimated capital and annual costs for each alternative are summarized in Table 3-8, and conclusions are presented in the following section.

3.2.2.3 CONCLUSIONS

The estimated present worth of the preliminary alternatives as presented in Table 3-8 indicate that the no action alternative has the lowest present worth in comparison to other alternatives. It should be noted, however, that this alternative has been determined to be under protective of human health and the environment and is only being evaluated further because this is required by EPA guidance.

The containment alternatives (i.e., low permeability cover and off-site RCRA landfill disposal) were determined to have present

TABLE 3-8 - PRESENT WORTH ESTIMATES FOR PRELIMINARY REMEDIAL ACTION ALTERNATIVES

Alternative	Est. Capital Cost (1988 Dollars)	Est. Annual Cost (1988 Dollars)	Present Worth* (1988 Dollars)
No Action	$0	$250,000	$ 2,275,000
Low Permeability Cover	$ 1,325,000	225,000	3,375,000
Off-Site RCRA Landfill	3,750,000	150,000	5,125,000
Solidification/Stabilization	2,375,000 to 3,775,000	150,000	3,750,000 to 5,150,000
On-Site Thermal Treatment			
Case I - Off-Site Ash Disposal	10,100,000	150,000	11,475,000
Case II - On-Site Ash Disposal/ Solidification/ Stabilization	8,700,000 to 10,100,000	150,000	10,075,000 to 11,475,000
Case III - On-Site Ash Disposal	7,875,000	150,000	9,250,000
Thermal Treatment At Love Canal			
Case I - Off-Site Ash Disposal	8,925,000	150,000	10,300,000
Case II - On-Site Ash Disposal Solidification/ Stabilization	7,575,000 to 8,950,000	150,000	8,950,000 to 10,325,000
Case III - On-Site Ash Disposal	6,725,000	150,000	8,100,000

* Based on a discount rate of 10 percent and a performance period of 25 years; P/A factor is equal to 9.077.

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of $3,375,000 to $5,125,000, respectively. Both of these alternatives will be evaluated further since neither is a magnitude of cost greater than the other, and EPA guidance requires the evaluation of at least one containment alternative.

The treatment alternatives (i.e., solidification/stabilization, on-site thermal treatment, and thermal treatment at Love Canal) cover a wide range of costs. Solidification/stabilization has the lowest estimated present worth of $3,750,000 to $5,150,000 while on-site thermal treatment (Cases I and II) have the highest estimated present worths of $11,475,000. Although the solidification/stabilization alternative will have the lowest overall cost, it has been determined that thermal treatment should still be considered further since the possibility exists that thermal treatment could result in permanent destruction of hot spot soil contaminants, and none of the thermal treatment alternatives are an order of magnitude more costly than solidification/stabilization.

In conclusion, Table 3-9 on the following page summarizes the preliminary alternatives discussed in this section, the status of each preliminary alternative with regard to further evaluation, and brief explanations of why preliminary alternatives which will not be considered further were eliminated.

TABLE 3-9 SUMMARY OF RESULTS OF SCREENING OF PRELIMINARY REMEDIAL ACTION ALTERNATIVES

PRELIMINARY ALTERNATIVES EVALUATED	STATUS	COMMENTS
I NO ACTION	To be considered	
II CONTAINMENT		
A. LOW PERMEABILITY COVER	To be considered	
B. OFF-SITE RCRA LANDFILL DISPOSAL	To be considered	
III TREATMENT		
A. SOLIDIFICATION/STABILIZATION	To be considered	
B. VITRIFICATION WITHIN EDA	Eliminated	Less protective than other treatment alternatives
C. ON-SITE THERMAL TREATMENT	To be considered	
1. Case I	To be considered	
2. Case II	To be considered	
3. Case III	To be considered	
D. THERMAL TREATMENT AT LOVE CANAL		
1. Case I	To be considered	
2. Case II	To be considered	
3. Case III	To be considered	

4 - Fin. Alts.

4.0 EVALUATION OF FINAL REMEDIAL ACTION ALTERNATIVES

The purpose of this section is to present detailed descriptions of each of the remedial action alternatives which passed preliminary screening. Then these 'final' alternatives are compared on the basis of the following criteria:

- Protection of Public Health and the Environment
- Compliance with ARAR's
- Reduction of Toxicity, Mobility or Volume
- Short-term Effectiveness
- Long-Term Effectiveness and Permanence
- Implementability
- Cost
- Community Acceptance
- State Acceptance

4.1 FINAL ALTERNATIVES DESCRIPTIONS

Final remedial action alternatives which were not eliminated during preliminary screening include no action, low permeability cover, off-site RCRA landfill disposal, solidification/stabilization, on-site thermal treatment and thermal treatment at Love Canal. Descriptions of these alternatives including the following information are presented in this section:

- the intent of the alternative
- key features
- control, storage, treatment and/or disposal requirements
- time considerations
- technical, administrative and health and safety factors
- maintenance and monitoring requirements

4.1.1 No Action

The intent of the no action alternative would be to leave the contaminated soils in place in an uncontained and untreated condition. This alternative could only be implemented if it was believed that public health and the environment would not be adversely affected. However, it was determined in the risk assessment presented in Section 6 of Volume I that the no action alternative would result in potential exposures of humans to contaminants resulting in an unacceptable level of risk. Over time, risks of these exposures might increase as more contaminated soils would become exposed due to wind and surface water erosion. Therefore, this alternative does not appear feasible since it would not be capable of adequately protecting human health and the environment.

If the no action alternative were selected, extensive monitoring of surface water and groundwater and periodic monitoring of dust levels would be required to ensure that nearby residents were not being exposed to potentially dangerous levels of site contaminants (i.e., levels exceeding ARARs). It is anticipated that detailed assessments of the monitoring data collected would have to be performed periodically to ensure that any trends of increasing levels of contamination in air, surface waters, and surface soils would be identified early so that measures to mitigate these increasing levels could be implemented quickly. In addition, site maintenance would also be required to minimize the potential effects of wind and surface water erosion on the vegetative cover and pavements currently overlying identified contaminated soils.

4.1.2 LOW PERMEABILITY COVER

Construction of a low permeability cover at the 93rd Street School site would be performed with the intent of containing the wastes on-site

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thereby preventing impacts associated with migration of contaminants via air or surface water at the site and to prevent direct contact risks. The cap would be designed and constructed so that it would have the following capabilities:

(1) Provide long-term minimization of migration of liquids through the underlying contaminated soils

(2) Function with minimum maintenance

(3) Promote drainage and minimize erosion or abrasion of the cover

(4) Accommodate settling and subsidence so that the cover's integrity is maintained

(5) Have a permeability less than or equal to the permeability of the natural subsoils underlying the contaminated fill materials.

The vegetative top layer should consist of a relatively thin layer of soils capable of supporting vegetation. The top slope of this layer should be sufficient (after settling and subsidence) to promote runoff and prevent the formation of erosion rills or gullies. The vegetation selected for the site should not require application of fertilizer, water, or mowing once plant growth is established. In addition, the vegetation should have a root system that will not penetrate beyond the base of the vegetative layer.

The low permeability layer would consist of a layer of native clay material compacted such that the permeability was less than or equal to the permeability of the natural subsoils of the site. It was estimated previously in Section 4 of Volume I that the natural subsoils at the site have permeabilities ranging from 10^{-3} to 10^{-7} ft/sec. The required thickness of this layer will be determined during the remedial design phase.

Drawing RAI in Appendix B shows the approximate extent of the proposed low permeability cover and a typical profile. It is anticipated that the cover would cover an area of approximately eight acres based on preliminary computations.

Implementation of this alternative would not result in a need for handling of the contaminated soils for treatment, storage, or disposal purposes. Some limited control technologies, however, would be required to prevent workers from coming into direct contact with the surface soils or from inhaling or ingesting contaminants prior to placement of the low permeability layer. Controls including use of appropriate respiratory protection and protective clothing should be used if this alternative is selected. In addition, noise control barriers may be desirable to reduce construction noise impacts on nearby residents.

Technical factors which could complicate implementation of this alternative might occur due to the increase in elevation of the covered area. It is anticipated that in order for the covered area to drain properly, the site will have to be regraded. In addition, the cover layers will increase the site elevation in the covered area. This change in elevation may make it necessary to raise existing monitoring wells, construct retaining walls (if the school is to remain in place), and to construct tree wells, access stairways and possibly other structures to compensate for the increase in elevation. This must be addressed in the remedial design phase. Other factors such as the potential reopening of the school might also affect the feasibility of this alternative since the eastern end of the site might be used as a playground.

It is anticipated that quarterly monitoring for groundwater quality would be required to ensure that contaminants were not leaching into the groundwater. In addition, a detailed assessment of the performance of the cover would be required every five years. Inspections of the cover and related structures would be required at least every six months. Any damage to the cover or related structures would have to be corrected soon after detection to prevent more serious degradation of the cover from occurring.

Finally, it is anticipated that this alternative would be effective both on a short and long-term basis in minimizing potential hazards due to migration of volatile and particulate emissions and direct contact exposures.

4.1.3 OFF-SITE RCRA LANDFILL DISPOSAL

Off-site RCRA landfill disposal of the hot spot soils from the 93rd Street School would be performed with the intent of removing all identified hot spot soils from the 93rd Street School site and permanently containing these soils at an EPA approved off-site RCRA landfill.

It has been estimated previously that the quantity of hot spot soils requiring remediation at the school site would be approximately 7,500 cu. yds. Following excavation, the excavated areas would be filled with clean fill from an off-site location, then a low permeability cover would be placed over the site as shown on Drawing RAI.

The hot spot soils would be loaded onto trailers approved by EPA and transported by a licensed hazardous waste hauler in accordance with the applicable EPA and State regulations to an EPA approved off-site RCRA landfill for disposal.

Control technologies that would be required during implementation of this alternative would include respiratory and protective clothing for workers at the site; decontamination equipment; dust controls potentially including water spraying and windscreening and temporary surface water controls to prevent migration of contaminants into Bergholtz Creek. Noise control barriers might also be desirable to reduce potential construction noise impacts.

Implementation of this alternative may be difficult if EPA approved landfills are not willing or able to accept the untreated hot spot soils. Two local landfills were contacted to determine whether or not they would be willing to accept these contaminated soils. CECOS of Niagara Falls, New York would not be willing to accept the hot spot soils at their New York facility because of the contaminants involved. They might, however, be willing to accept the soils at their Ohio facility, although they anticipate that the fact that there might be a few isolated portions of the soils which contain low levels of dioxin may hinder the acceptability of the soils for land disposal at any facility.

SCA of Lewiston and Porter, New York was also contacted. It was determined that SCA would not be willing to accept the soils unless it could be proven that they did not contain dioxin. This would be virtually impossible since in previous studies of the site, NUS and RECRA both identified dioxin in the hot spot area at levels exceeding 1 ppb. In addition, even if the soils could pass the TCLP test, SCA felt that the quantity of soils was relatively large and that it might be difficult for them to accept the entire volume.

Maintenance and monitoring at the 93rd Street School site would be required after excavation of the soils and disposal off-site since other less contaminated soils would be present at the site beneath the low permeability cover.

On a short-term basis, this alternative would result in greater potential risks of emissions of volatiles, particulates, and of direct contact. Surface water and dust controls could be used to minimize particulate emissions to the air and surface water, and direct contact controls such as limiting access to the site could be used to reduce direct contact risks. Although volatile emissions would be almost impossible to control, it is anticipated that risks associated with these emissions would be virtually negligible as described previously in the public health and environmental risk assessment.

4.1.4 SOLIDIFICATION/STABILIZATION

Solidification/stabilization of hot spot soils would be implemented to stabilize wastes to reduce the potential for volatile and particulate emissions and direct contact risks. Steps that would be required would include excavation of hot spot soils; solidification/stabilization of the soils; sampling and analysis to verify that treated soils are delistable or meet hybrid closure requirements; placement of the treated soils on-site; and placement of a low permeability cover.

There are a number of solidification/stabilization systems which could be used at the site including processes developed by Hazcon, Inc., Soliditech, Inc., Chemfix Technologies, Inc., Waste Chem Corporation, Environmental Protection Polymers and the United State Gypsum Co. Most of these processes were described in detail in Section 2 (refer to Section 2.1.2.2.2 for descriptions of the Hazcon, Soliditech and Chemfix technologies and to Section 2.1.2.2.4 for a description of the Waste Chem technology). Since detailed descriptions of surface microencapsulation technologies were not described previously in Section 2, however, information about these technologies is presented in the following paragraphs.

One surface microencapsulation process developed by Environmental Protection Polymers would involve placing the hot spot soils into high density polypropylene overpacks onto which covers would be spin welded using a special mobile welding apparatus. The resulting encapsulate would be seam free and capable of preventing volatile and particulate emissions and direct contact risks on a long term basis. Costs of this particular technology were estimated by Environmental Protection Polymers as $50 to $70 per 80 gallon drum in 1983 dollars (Ref. 1).

Another method developed by Environmental Protection Polymers would involve mixing 1,2-polybutadiene with the hot spot soil particles to form a free flowing mass of dry resin coated particulates (after solvent evaporation). These coated particulates would then be mixed with high density polyethylene to form a ductile mass. Finally, a thin high density polyethylene jacket would be mechanically and chemically locked onto the surface of the ductile mass thereby encapsulating the wastes. The cost of this technology was estimated by Environmental Protection Polymers as $90 per ton in 1983 dollars (Ref. 1). It is anticipated that this method would result in a greater volume increase than the first method described.

Finally, United States Gypsum Co. has developed an encapsulation technology in which a polymer modified gypsum cement called Envirostone Cement is mixed with wastes (typically oils and radioactive wastes) along with emulsifiers and ion exchange resins. Following mixing, the cement hydrates to form a free standing mass in which both organic and inorganic wastes are stabilized. Discussion of this method with a representative of the United States Gypsum Co. revealed that this particular technology would not be appropriate for encapsulation of the contaminated soils from the 93rd Street School for the following reasons:

- this technology has not been demonstrated effective in treating contaminated soils
- the moisture content of the soils would be too high for proper curing of the cement
- even if the soils were dried, and then microencapsulated, it would not be appropriate to dispose of the microencapsulated materials on-site unless a RCRA grade containment was built to house them.

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Each solidification/stabilization technology would have to be subjected to a detailed evaluation prior to selection to ensure that it would be capable of mitigating the potential risks associated with volatile and particulate emissions and direct contact on a long-term basis and that it would not require RCRA grade secondary containment for redisposal at the site. If, as a result of pilot testing it was determined that a particular technology could not render the hot spot soils either delistable or capable of meeting hybrid closure requirements, that technology would be eliminated from further consideration.

Control technologies required during implementation of this alternative would be essentially the same as those described previously for off-site RCRA landfill disposal of the soils. Additional storage requirements might be necessary depending upon the time required to treat the wastes. Therefore, it would be preferable to select a solidification/stabilization technology which could be performed as the soils were excavated so that construction of a temporary hazardous waste storage facility would not be required.

It is anticipated that even if a solidification/stabilization technology were selected which would render hot spot soils delistable, placement of a low permeability cover as shown on Drawing RAI would still be necessary because of underlying contaminated soils. In addition, it is also anticipated that quarterly groundwater monitoring and detailed five year assessments of the performance of the site would be required to ensure that the contaminants were not migrating from the treated hot spot soils or untreated identified contaminated soils.

In conclusion, on a short-term basis, this alternative would result in greater potential risks of emissions of volatiles and particulates as well as greater short-term direct contact risks than for the no action, low permeability cover or off-site landfill disposal alternatives. As described previously, however, it is anticipated that particulate emissions and direct contact risks could be controlled during excavation and handling of hot spot soils. In addition, the long-term effectiveness of this alternative is anticipated to be better overall than that of the containment or no action alternatives.

4.1.5 THERMAL TREATMENT ALTERNATIVES

On-site thermal treatment would be performed with the intent of permanently treating the hot spot soils so that treatment byproducts would be delistable or would meet hybrid closure requirements (Case III). If, however, no mobile treatment unit was available which could achieve this result, then a unit capable of reducing the levels of contaminants in the soils might be selected. Following treatment, the partially treated byproducts could then be disposed either at an approved off-site landfill (Case I) or on-site following treatment via a solidification/stabilization technology capable of rendering the byproducts delistable or acceptable for hybrid closure (Case II). It should be noted that some thermal treatment units might be capable of generating a delistable ash while also generating small quantities of hazardous air emission control byproducts. Disposal of wastes from such units would require a combination of the disposal strategies used in Cases I to III.

Steps involved in implementing this alternative would include excavation of hot spot soils, followed by thermal treatment and residual waste disposal. The activities involved would vary depending upon the mobile thermal treatment unit selected. A recent listing of some of the available (or potentially available) units is presented in Table 4-1 (from EPA, Ref. 4). Brief descriptions of the key features of these units were presented previously in Section 2. Based on these descriptions, it was determined that the ideal

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TABLE 4-1 PLANNED AND EXISTING TRANSPORTABLE THERMAL TREATMENT SYSTEMS (From EPA, Ref. 4)

UNIT	EXISTING YES/NO	PLANNED DATE OF COMPLETION DESIGN	PLANNED DATE OF COMPLETION FABRIC	ACCEPTABLE WASTE	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS COMBUSTION ZONE RETENTION TIME	APPROX. SOILS CAPAC. (TONS/HR) AT 20% MOIST.	BURN DATA TYPE/RESULTS	PERMIT STATUS GRANTING PERMIT/DATA/AGENCY	COMMENTS
1-OGDEN ENVIRON. SERVICES San Diego, CA (Circulating Bed Combustion (CBC) Incinerator)										
-16-inch ID, 2MBtu/hr transportable CBC pilot unit exists	Yes			liquid, solids	1400 to 1800	Solids- minutes to hours gases->2 sec.	1.0	TSCA-Conducted on transp. pilot unit 5/85. DRE > 99.9999% for PCB 1248 and 1260 at 10,000ppm & trichlorobenzene at 1,000ppm.	RD+D permit for transp. pilot unit in EPA Reg. IX. (2/87).	
-16-inch ID, 2MBtu/hr transportable CBC unit	Yes		late 1985	*	*	*			TSCA- Transportable units approved for PCB soils 3/86.-EPA HQ	The 16-in. ID unit has been delivered to a Canadian organiz.
-36-inch ID 6-9MBtu/hr transportable CBC unit in construction	No	4/86	Aug-Sept 1987	*	*	*	2.5			Expect to conduct burns with the 36-inch ID unit under the SITE program at a Reg. IX site(summer '87)
2-ENSCO/PYROTECH Franklin, TN (Rotary Kiln Incinerator)										
-180MBtu/hr rotary kiln, waste fired boiler fixed facility	Yes									
-Two 10MBtu/hr liquid injection mobile incinerator	Yes									
-Three 35MBtu/hr rotary kiln transportable incinerators- (MWP-2000)										
Unit 1	Yes	11/83	12/84	liquids, solids	kiln-1200 to 1800 S'dary-1400- Combust. 2400	Solids-20 min. to 1 hour gases-2 sec.	4.0	Unit 2 RCRA-Conducted Reg. VI trial burn 3/86. Achieved four 9's for RCRA surrogate. Need to repeat tests with a new dioxin surrogate since all tests didn't reach six 9s. TSCA- (3/86) trial burn results indicate seven 9's DRE for PCB contaminated liquids and soils.	Unit 2 RCRA- Permit application and demonstration test plan approved by OTS; HQ TSCA-Same status with Reg. VI. Expect decision on TSCA permit (4/87).	Unit 1 has burned septage and contaminated oil. It is being retrofitted for work at an Illinois RCRA site. Expect unit 2 to operate at the Vertac dioxin site.
Unit 2	Yes	11/83	7/85	*	*	*	*			
Unit 3	Yes	11/83	3/86	*	*	*	*			
Unit 4	No	11/83	7/87	*	*	*	*			
Unit 5	No	11/83	9/87	*	*	*	*	Unit 3 DOD demonstration burn results for	Unit 3 RD&D permit for DOD cleanup.	Unit 3 is at the Gulfport, MS Dept. of Defense dioxin site.

TABLE 4-1 PLANNED AND EXISTING TRANSPORTABLE THERMAL TREATMENT SYSTEMS (Continued)
(From EPA, Ref. 4)

UNIT	EXISTING YES/NO	PLANNED DATE OF COMPLETION DESIGN	FABRIC	ACCEPTABLE WASTE	OPERATING CONDITIONS TEMPERATURE (F)	COMBUSTION ZONE RETENTION TIME	APPROX. SOILS CAPAC. (TONS/HR) AT 20% MOIST.	BURN DATA TYPE/RESULTS	PERMIT STATUS GRANTING PERMIT/DATA/AGENCY	COMMENTS
3-J.M. HUBER * Borger, TX (Advanced Electric Reactor (AER) Pyrolysis)										
-3-inch core AER field demonstration unit-mounted in a single 45ft. trailer	Yes							3 inch unit has dioxin soil burn data from Times Beach testing. Both the 3 inch and 12 inch have burn data for octachlorodibenzo dioxin. 12 inch unit achieved six 9's plus, with PCB-contaminated soils.	RCRA- Both the 3 inch and 12 inch units have Part B's(including dioxin),10/85- Texas Water Commission. TSCA- 12 inch unit has TSCA for PCBs, 5/84-EPA Region VI.	Pretreatment system included to crush and grind solids to a fine material. Solids must contain less than 3% moisture.
-6-inch core fixed AER in Borger, TX. Used for certf. tests	No	complete	10/86							
-12-inch core fixed AER in Boger, TX. Commercial size, but used for R+D and certification tests	Yes						1.5			
-24-inch core AER is possible if demanded	No	depends on demand					6.0			
-Transportable AER	No	design is 95% compl.	Indefin. Would req 9-12 mo.	liquids, solids	3600 to 4500	less than 2 seconds	2.5			Huber will not finalize the design & begin fabrication of a transportable unit until they procure a full-scale commercial job for it.

* Huber is no longer accepting any toxic or hazardous waste at either their fixed or transportable units for at least the next two years. This decision is based on poor market conditions.

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TABLE 4-1 PLANNED AND EXISTING TRANSPORTABLE THERMAL TREATMENT SYSTEMS (Continued) (From EPA, Ref. 4)

UNIT	EXISTING YES/NO	PLANNED DATE OF COMPLETION DESIGN	PLANNED DATE OF COMPLETION FABRIC	ACCEPTABLE WASTE	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS COMBUSTION ZONE RETENTION TIME	APPROX. SOILS CAPAC. (TONS/HR) AT 20% MOIST.	BURN DATA TYPE/RESULTS	PERMIT STATUS GRANTING PERMIT/DATA/AGENCY	COMMENTS
4-SHIRCO INFRARED SYSTEMS Dallas, TX (Infrared Furnace)								RCRA-4/86-Confidential 5/86-Confidential 6/86-Confidential 8/86-Confidential TSCA-3/86-Confidential 4/85-Simulated creosote and Pentachlorophenol contaminated soils test burn-five 9's DRE for pentachlorophenol at detection level. 7\85-Times Beach dioxin contaminated soil results indicate six 9's DRE were achieved. TCDD in ash and scrubber water was non-detect at 0.4ppb and 1.0ppb detection levels respectively. 11/85-Creosote and Penta-chlorophenol and dioxin contaminated soils test burn for International Paper Co.-MO. Six 9's DRE achieved on various POHC's.		A mobile pilot unit was used at EPA Region 1 Tibbetts Rd. Superfund site in 11/86 on 4cy of dioxin-contaminated soils. Results expected 4/87. EPA ORD has a Shirco unit in storage (300 lb. soil/hr). Shirco infrared systems are also used for regenerating activated carbon. First full-scale transportable unit was purchased by Haztech Inc. and is being used at the Peak Oil Superfund site(PCB-contaminated) in Florida. Three additional full-scale transp. units purchased by O.H. Materials, IT Corp. and Reidel Inc. are expected to be completed fabrication in mid-1987. Additional transp. units will be fabricated upon demand.
-(3) Existing mobile Pilot Units (100#/hr)	Yes			liquids, solids	Pri. chamber 1600 to 2000 After burner 1800 to 2300	Primary chamber 5 to 90 minutes. After burner 2.2 seconds	100lbs/hr.			
-Existing fixed Pilot Unit (100#/hr)	Yes			*	*	*	100lbs/hr.			
-Transportable Unit 5 tons/hr- 50MBtu/hr	Yes			*	*	*	5.0 to 8.0			
-3 addit. trans. units 5tons/hr- 50MBTU/hr	No	Complete	Jun-Aug 1987	*	*	*	*			
-1 tons/hr transp.	No	Complete	Fall 1987	*	*	*	1.0 to 1.5			
5-DETOXCO Pittsburg, CA (Rotary kiln incinerator)										
-Transportable rotary kiln incinerator 94MBtu/hr.	No	complete	Would req. aproxim. 10 months	liquids, solids	kiln-1800. secondary combust.-2200.	gases-)2 sec.	16.0	None. Although EPA mobile incinerator permit status and burn data may be of some benefit.	None. (see Burn Data column)	This unit design is a scaled-up version of EPA's mobile unit, which DETOXCO fabricated. The new design reflects experience gained in operation of the mobile unit. Fabrication of a unit is about

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TABLE 4-1 PLANNED AND EXISTING TRANSPORTABLE THERMAL TREATMENT SYSTEMS (Continued)
(From EPA, Ref. 4)

UNIT	EXISTING YES/NO	PLANNED DATE OF COMPLETION DESIGN	PLANNED DATE OF COMPLETION FABRIC	ACCEPTABLE WASTE	OPERATING CONDITIONS TEMPERATURE (F)	OPERATING CONDITIONS COMBUSTION ZONE RETENTION TIME	APPROX. SOILS CAPAC. (TONS/HR) AT 20% MOIST.	BURN DATA TYPE/RESULTS	PERMIT STATUS GRANTING PERMIT/DATA/AGENCY	COMMENTS
6-EPA MOBILE INCINERATOR										
-Mobile rotary kiln incinerator-15MBtu/hr.	Yes			liquids, solids	kiln-1800 secondary combust.-2200	gases->2 sec.	1.0	Successful PCB and dioxin burn data.	National NEPA and TSCA. Region VII for dioxin. Ash has been delisted.	Capacity is not great enough to justify treating the Creek sediment. The units hardware is currently being upgraded to increase capacity and overall efficiency.
7-PEDCO Cincinnati, OH (Cascading Rotary Incinerator)										
-3ft. inner diameter 20ft. long pilot unit is operating at Rollins, NJ	Yes			liquids solids	1400 to 1700	solids- 15 to 20 minutes. gases->2 sec.	1.0 to 2.0	Rollins has used the unit for test burns. Availability of this data is questionable.		The unit was designed and fabricated by PEDCO. It was owned by Rollins of NJ. PEDCO now owns the unit and plans to convert it to a mobile unit.
-6ft. inner diameter 25ft. long unit is serving as a coal fired boiler in Ohio.	Yes			*	*	*		Test burns of chlorinated solvents co-fired with coal were conducted in the fall of 1986.		
-Additional units could be completed if demand is present.	No		Indefin. Would req. 6 months.	*	*	*				
8-WESTINGHOUSE PLASMA SYSTEMS (Plasma Arc Pyrolysis)										
-One completed plasma arc mobile unit exists (NYSDEC)	Yes			liquid (pumpable) organic wastes	9000	atomization zone (a few thousands of a second. recombination zone 1 to 2 seconds	soils-N/A liquids-1 to 2.5 gal/min.	The unit has successfully burned carbon tetrachloride, methyl ethyl ketone and PCBs in Canada. Results indicate six + 9's were achieved.	Compliance with substantive requirements of NEPA and RCRA is being reviewed by EPA Region 2 and NYSDEC.	NYSDEC will demonstrate the existing unit at Love Canal. It should be noted that present plans call for the unit to treat Love Canal leachate treatment plant sludge only.
-Another plasma arc mobile unit planned for commercial use.	Yes		late 1986	*	*	*	soils-N/A liq.- 3 gal/min.			
-Electric Pyrolyzer				solids			5.0 tons/day	Test burned surrogate materials in Reg. IV. Results are not		Similar to Huber/Thagard AER. Trying to upgrade to 30 tons/day.

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TABLE 4-1 PLANNED AND EXISTING TRANSPORTABLE THERMAL TREATMENT SYSTEMS (Continued) (From EPA, Ref. 4)

UNIT	EXISTING YES/NO	PLANNED DATE OF COMPLETION DESIGN	FABRIC	ACCEPTABLE WASTE	OPERATING CONDITIONS TEMPERATURE (F)	COMBUSTION ZONE RETENTION TIME	APPROX. SOILS CAPAC. (TONS/HR) AT 20% MOIST.	BURN DATA TYPE/RESULTS	PERMIT STATUS GRANTING PERMIT/DATA/AGENCY	COMMENTS
9-THAGARD RESEARCH CORP. Costa Messa, CA (High Temperature Fluid-Wall (HTFW) Reactor Pyrolysis)										
-12-inch core mobile unit is presently in storage.	Yes			liquids solids	4000		1.5 to 2.0	Six 9's with hexa-chloro-benzene. See also Huber AER burn data.		Huber's 12" AER was designed and built by Thagard. Feed material must be ground finely.
10-FULLER POWER CORP. Bethlhem, PA (Rorary kiln incinerator)										
-Transportable rotary kiln incinerators. -2 tons/hr. -4 tons/hr. -8 tons/hr. -Additional units available upon demand	No	complete		liquids solids	kiln- 1800 to 2000 second. combust. 2200 to 2400	gases)2 sec.				Fuller will not fabricate a unit unless a full-scale job is procured. 8 to 10 mo. are required to fabricate.
11-IT CORP. Knoxville, TN	IT Corp. failed to respond to the questionaire. They are, however, currently pursuing the potential for utilization of conventional incineration of liquids and solids at hazardous waste sites. These units will be transportable and have recently completed the detailed design stage. Fabrication of a unit is expected to be completed in 1987.									

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unit would be capable of addressing both the metal and organic contaminants present in site soils; require minimal feed preparation which could result in increased air emissions and noise pollution; generate minimal hazardous byproducts such as ash and air emissions; and function efficiently to minimize treatment time requirements.

Extensive control technologies would be required if this alternative were implemented. Controls required during excavation would be similar to those described previously for the off-site RCRA landfill disposal or solidification/stabilization alternatives. If feed preparation operations such as pulverization or drying were required, then controls would be required to minimize worker contact with the soils during handling operations, to minimize particulate and possibly volatile emissions, and to minimize noise pollution. During thermal treatment, air pollution controls would be required to prevent potential escape of hazardous byproducts. Finally, if the treatment byproducts were hazardous, workers would have to be equipped with the appropriate respiratory and other protection equipment to handle the partially treated ash and scrubber waters.

Temporary storage of the untreated hot spot soils may be required prior to thermal treatment. In addition, if the residual ash and other treatment byproducts are determined to be hazardous, these wastes may also have to be stored on-site prior to treatment and/or disposal. Although some of the mobile treatment units are equipped with temporary storage containments, it is anticipated that temporary storage of all 7,500 cubic yards of hot spot soils to be excavated may pose a problem at the site. Therefore, it may be necessary to excavate small portions of the site at a time rather than excavate all hot spot soils at once to reduce storage requirements for untreated hot spot soils, or to construct a new storage facility.

The time required for treatment of the hot spot soils would vary from approximately 2 to 21 months based on 24 hr/day, 365 day/year, 75 percent efficient operation depending upon the mobile unit selected. The units listed in Table 4-1 were capable of treating 1 to 16 tons/hr at 20 percent moisture content. It is possible, however, that units not included on this list may be capable of handling even more than 16 tons/hr. However, these units may be larger and therefore they may have longer mobilization and demobilization times. It is anticipated that a "test burn" would be required prior to selection of a final thermal treatment unit for use at the site to determine the level of treatment attainable, the effectiveness of air pollution controls, the time required for treatment, and to identify any problems associated with thermally treating the hot spot soils from the 93rd Street School site. Analysis of the byproducts from a test burn could be used to establish whether or not they would be considered hazardous, delistable, or capable of meeting hybrid closure requirements and therefore whether off-site RCRA landfill disposal (Case I), solidification/stabilization (Case II) or direct on-site disposal (Case III) would be recommended.

Maintenance and monitoring requirements for all cases would include maintenance of the mobile thermal treatment unit, and monitoring of emissions and byproducts to ensure protection of public health and the environment. Depending upon the disposal method allowed, long-term monitoring and maintenance requirements would vary. For Cases I and II, requirements will be essentially the same as those described previously for the off-site RCRA landfill disposal and solidification/stabilization alternatives, respectively. For Case III, however, it is anticipated that long-term maintenance and monitoring at the site will be approximately the same as that for the off-site RCRA landfill disposal alternative.

In conclusion, the potential short-term effectiveness of this alternative in protecting human health and the environment is worse than for all other alternatives due to the potential for emissions during excavation as well as during storage of untreated soils, feed preparation, thermal treatment, and hazardous byproducts disposal. The long-term effectiveness, however, will be better than that of other alternatives.

4.2 COMPARISON OF FINAL REMEDIAL ACTION ALTERNATIVES

4.2.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

CERCLA as amended by SARA requires that remedial action alternatives be protective of human health and the environment. Protection should be ensured by selecting an alternative which will reduce threats to acceptable levels and which will not result in potential future impacts on human health and the environment via any exposure pathway.

In Section 3, most alternatives which were judged to be under-protective of human health and the environment were eliminated from further consideration. Thus almost all of the final alternatives being evaluated in this section are considered to be protective of human health and the environment in varying degrees with the exception of the no-action alternative and the possible exceptions of the low permeability cover and off-site RCRA landfill disposal alternatives which do not provide for treatment of hot spot soils.

It has been determined that the no action alternative will not be capable of adequately protecting human health and the environment on a short term basis due to the fact that particles in contaminated surface soils may become airborne, may be transported via surface water runoff or may come into direct contact with humans and other life forms at the site. Over time, it is anticipated that potential exposure risks may increase due to the fact that wind and surface water erosion could expose greater portions of the contaminated soils.

The low permeability cover alternative will provide the greatest level of protection on a short-term basis since excavation and handling of the contaminated soils will not be required, and as soon as the low permeability soils are placed, the short-term risks associated with the no action alternative

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will be mitigated. A site specific plan for worker health and safety should be drafted and implemented to protect workers during site remediation. Occupational Safety and Health Administration (OSHA) as well as more stringent state regulations should also be followed by workers at the site to minimize the potential for harmful exposures and remediation related accidents. The long-term effectiveness of this alternative is anticipated to be adequate for protection of human health and the environment providing that the cover is properly maintained and the site is inspected and monitored on a regular basis. If contaminated soils in the hot spot area are eventually exposed, however, significant health risks may be posed by the site.

Off-site RCRA landfill disposal of the hot spot soils will require that these soils be excavated, loaded onto trailers, and transported to an EPA approved off-site landfill. As for the low permeability cover alternative, a plan for protection of worker health and safety as well as pertinent OSHAand more stringent state standards should be followed throughout remediation of the site. It is anticipated that workers at the site can be adequately protected from potentially harmful exposures. In addition, it is also believed that nearby residents can be adequately protected from airborne particulates, surface water contamination and direct contact with contaminated soils providing the proper controls are employed. The long-term effectiveness of this alternative will be good at the 93rd Street School site since hot spot soils will be removed from the site. At the off-site RCRA landfill, however, the long-term effectiveness will be dependent upon the proper maintenance of the containment.

Solidification/stabilization of the wastes at the site would result in only slightly greater short-term exposure risks than those described previously for the off-site RCRA landfill disposal alternative providing that the appropriate worker health and safety and OSHA and more stringent state are followed throughout site remediation. Long-term risks will vary depending upon the degree of permanence of the solidification/stabilization treatment selected. During preliminary testing, therefore, it should be demonstrated that deterioration of the solidified/stabilized hot spot soils will not occur such that the residuals will pose a significant risk as a result of erosion.

On-site and off-site thermal treatment of the contaminated soils would result in the same excavation related risks as those described previously for the off-site RCRA landfill disposal and solidification/stabilization alternatives. Additional risks of vapor and particulate emissions would occur for the on-site thermal treatment alternative during soils handling, storage, feed preparation, and thermal treatment. It is anticipated that workers at the site (for on-site treatment) or at Love Canal (for thermal treatment at Love Canal) could be adequately protected throughout site remediation by following a worker health and safety plan and the appropriate OSHA and more stringent state standards. Through implementation of air emission, surface water and direct contact controls, it is also anticipated that nearby residents could be adequately protected from exposure to airborne particulates, water borne particulates, and direct contact with contaminated soils.

The long-term effectiveness of these alternatives is dependent upon whether or not the contaminated soils can be treated so that they are delistable or disposable under hybrid closure standards (Cases II and III). If this goal can be achieved, then either on-site thermal treatment or thermal treatment at Love Canal will provide the greatest long-term protection of human health and the environment. If, however, the residual ash remains hazardous, and is disposed at an off-site RCRA landfill (Case I), then the long term effectiveness at the 93rd Street School site will be virtually the same as that of the off-site RCRA landfill disposal alternative.

It should be noted that another potential impact of site remediation on nearby residents is noise pollution. While not life threatening, noise related to construction activities and remedial treatment implementation could be an irritation. The least noise pollution would occur if the no action alternative were implemented. All other alternatives, however, would involve noises related to trucks bringing materials and equipment to and from the site and site work. Although sound barriers could be constructed to minimize on-site noise pollution, noise control for trucks entering and leaving the site would be virtually impossible. The alternatives that may generate the greatest noise impact are solidification/stabilization and on-site thermal treatment since additional noise pollution may occur during feed preparation (particularly if pulverization is required) and during treatment. If an on-site thermal treatment unit is to be operated on a 24 hour per day basis, then the noise may be particularly disturbing to nearby residents. Therefore, if on-site thermal treatment will be performed, noise reduction capabilities of the proposed thermal treatment unit should be evaluated.

4.2.2 COMPLIANCE WITH ARARS

Section 121(d) of CERCLA as amended by SARA requires that Fund-financed, enforcement, and Federal facility remedial actions comply with legally applicable or relevant and appropriate requirements (ARARs) of federal laws and more stringent promulgated state environmental and public health laws. These ARARs typically fall into the following categories:

- Contaminant specific ARARs (e.g. NYSDEC air, surface water, groundwater standards, etc.)
- Location specific ARARs (e.g. restrictions on actions at historic preservation sites, in areas of seismic activity etc.)
- Action specific ARARs (e.g. RCRA requirements for incineration, closure, etc.)

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It should be noted that in some cases, alternatives that do not attain ARARs may be acceptable if they are included in one or more of the six waiver categories allowed by SARA in 121(d)(4).

"Applicable" requirements include cleanup standards, standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site. "Relevant and appropriate" requirements, however, include cleanup standards, standards of control and other environmental protection requirements, criteria, or limitations promulgated under Federal or state law that are not applicable but do address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the site.

Ambient or chemical specific ARARs are set based on health or risk related concentration limits or ranges of hazardous substances, pollutants or contaminants in various environmental media such as air or water. For the 93rd Street School site, NYSDEC Ambient Water Quality Standards could be used to determine what levels of surface water and groundwater contamination would be acceptable, while National Ambient Air Quality Standards (NAAQSs) or more stringent NYSDEC Air Quality Standards could be used to determine what levels of air emissions would be acceptable. Additional chemical specific health based advisory levels could be used for contaminants for which the ARARs mentioned above are not available. Table 4-2 on the following page lists examples of possible ambient and chemical specific ARARs applicable to the 93rd Street School site for the parameters of concern. Public health and environmental risks associated with site contaminants were discussed previously in Section 6 of Volume I - Remedial Investigation Summary.

TABLE 4-2 - EXAMPLES OF AMBIENT AND CHEMICAL SPECIFIC ARARs

Contaminant	AIR NYSDEC Air Guideline, mg/m^3	GROUNDWATER NYSDEC WQ GA Stds. & Guides., ug/l	SURFACE WATER NYSDEC WQ Class A Stds. & Guides., ug/l
Antimony	6.7×10^{-4}	3	3
Arsenic	6.7×10^{-4}	25	50
Lead	1.5×10^{-3}	25	50
Mercury	3.3×10^{-4}	2	2
Benzo (a)anthracene	None	0.002	0.002
Benzo (b)fluoranthene	None	0.002	0.002
Benzo (a)pyrene	None	ND	0.002
Chrysene	None	0.002	0.002
Indeno [1,2,3-cd] pyrene	None	0.002	0.002
Dioxin	None	0.000035	0.000001

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Locational ARARs set requirements for the locations where certain remedial action activities can be performed depending upon the characteristics of the site and its immediate surroundings. Federal locational standards for permitted hazardous waste facilities are presented in 40CFR264.18. While these standards are not applicable to the 93rd Street School site, certain standards may be relevant and appropriate including standards for RCRA facilities located within the 100 year flood plain (portions of the contaminated soils to be covered with a low permeability cover may lie at the edge of the 100 year flood plain) and potentially with standards for facilities in areas of seismic activity (Niagara Falls is located in an area of significant seismic activity). The requirements of any additional more stringent NYSDEC locational ARARs should also be met.

Performance, design or other action specific ARARs should be used to restrict or control activities related to management of hazardous substances, pollutants or contaminants. Examples of these standards which would be applicable to the remedial action alternatives being considered for use at the 93rd Street School site include the following:

- RCRA regulations and more stringent state regulations pertaining to hazardous waste generators (40CFR262 and 6NYCRR Part 372, respectively).
- RCRA regulations and more stringent state regulations pertaining to hazardous waste disposal units (40CFR264 and 6NYCRR Part 373, respectively).
- RCRA regulations and more stringent state regulations pertaining to incinerators (40CFR264, Subpart O)

Finally, it should be noted that CERCLA 121(e) exempts any on-site response action from having to obtain a Federal, state or local permit. However, the substantive requirements of permit regulations must be followed.

Because it is impossible to describe in detail all ARARs that should be considered, Table 4-3 which lists New York State ARARs has been included for reference purposes.

TABLE 4-3
NEW YORK STATE ARAR's

New York State Department of Environmental Conservation

° Division of Solid and Hazardous Waste

- Description of Difference - EPA/State Regulations
- 6NYCRR Part 360 - Solid Waste Management Facilities
  361 - Siting of Industrial Hazardous Waste Facilities
- Article 27, Title 11 of the ECL - Industrial Siting Hazardous Waste Facilities
- 6NYCRR Part 364 - Waste Transporter Permits
- Proposed Amendments to 6 NYCRR Part 370 and 373
- 6 NYCRR Part 370 - Hazardous Waste Management System: General
  371 - Identification and Listing of Hazardous Wastes
  372 - Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities
- 6 NYCRR Subpart 373-1 - Hazardous Waste Treatment, Storage & Disposal Facility Permitting Requirements
  Subpart 373-2 - Final Status Standard for Owners and Operators of Hazardous Waste TSD Facilities
  Subpart 373-3 - Interim Status Standards for Owners and Operators of Hazardous Waste Facilities
- 6 NYCRR Part 374 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
  375 - Inactive Hazardous Waste Disposal Sites
  621 - Uniform Procedures
  624 - Permit Hearing Procedures

° Division of Water

- 6 NYCRR Part 703 - NYSDEC Groundwater Quality Regulation
- 6 NYCRR Part 750-757 - Implementation of NPDES Program in NYS
- 6 NYCRR - Parts 701
  702 - Surface Water Quality Standards
  704
- 6 NYCRR Part 701.15 (d) and (e) Empowers DEC to Apply and Enforce Guidance where there are no Promulgated Standards
- Technical and Operations Guidance Series (TOGS)
  85-W-40; July 12, 1985 - Analytical Detectability for Toxic Pollutants
  1.1.1; April 1, 1987 - Ambient Water Quality Standards and Guidance Values
  1.2.1; May 19, 1987 - Industrial SPDES Permit Drafting Strategy for Surface Waters
  1.2.1; May 22, 1987 - Waste Assimilative Capacity Analysis for Setting Water Quality Based Effluent Limits
  1.3.2; April 1, 1987 - Toxicity Testing in the SPDES Permit Program
  1.3.4; April 1, 1987 - BPJ Methodologies
  1.6.1; April 1, 1987 - Regional Authorization for Temporary Discharges
  2.1.2; April 1, 1987 - Underground Injection/Recirculation (UIR) at Groundwater Remediation Sites

TABLE 4-3 (Continued)
NEW YORK STATE ARAR's

° Division of Air

- 6 NYCRR Part 200 (2006) - General Provisions
- 6 NYCRR Part 201 - Permits and Certificates
- 6 NYCRR Part 211 (211.2) - General Prohibitions
- 6 NYCRR Part 212 - General Process Emission Sources
- 6 NYCRR Part 257 - Air Quality Standards
- Air Guide 1 - Guidelines for the Control of Toxic Ambient Air Contaminants

° Division of Marine Resource, Bureau of Marine Habitat Protection

- Chapter 10 of 6 NYCRR Part 661 Tidal Wetlands - Land Use Regulations

° Division of Fish and Wildlife

- 6 NYCRR Part 608 - Use and Protection of Waters
- 6 NYCRR Parts 662 - Freshwater Wetlands - Interim Permits
  663 - Freshwater Wetlands Permit Requirements
  664 - Freshwater Wetlands Maps and Classifications
  665 - Local Government Implementation of the Freshwater Wetlands Act and State Wide Minimum Land-Use Regulations for Freshwater Wetlands
- 6 NYCRR Part 182 - Endangered & Threatened Species of Fish and Wildlife
- ECL Article 24 and Article 71, Title 23 - Freshwater Wetlands Act

° Division of Mineral Resources

- 6 NYCRR Part 420 - General
  421 - Permits
  422 - Mined Land-Use Plan
  423 - Reclamation Bond
  424 - Enforcement
  425 - Civil Penalties
  426 - Hearings

- Title 27 - NYS Mined Land Reclamation Law

New York State Department of Health

- NYSDOH PWS 69 - Organic Chemical Action Steps for Drinking Water
- NYSDOH PWS 159 - Responding to Organic Chemical Concerns at Public Water Systems
- The 10 ppt criterion for 2,3,7,8-TCDD in fish flesh
- The Binghamton State Office Building clean-up criteria for PCDDs, PCDFs and PCBs

TABLE 4-3 (Continued)
NEW YORK STATE ARAR's

- Part 5 of the State Sanitary Code, Drinking Water Supplies
- Part 170 of Title 10 of the NYCRR, Water Supply Sources
- Appendix 5-A of Part 5 of the State Sanitary Code (Recommended Standards for Water Works)
- Appendix 5-B of Part 5 of the State Sanitary Code (Rural Water Supply)
- Five Environmental Health Manual items dealing with chemical contamination of public drinking water supplies
- Draft documentation for the generic organic chemical standards in drinking water
- NYSDOH Interim Report on Point-of-Use Activated Carbon Treatment Systems
- Part 16 draft limits on the disposal of radioactive materials into sewer systems
- Criteria for the development of health advisories for sport fish consumption
- Tolerance levels for EDB in food.

New York State Department of Labor

12 NYCRR 50 - Lasers
12 NYCRR 38 - Ionizing Radiation Protection

New York State Department of Agriculture and Markets

1 NYCRR Part 371 - Notice of Intent

° Coastal Management

- Part 600 - Department of State, Waterfront Revitalization and Coastal Resources Act

- State Coastal Policies
- State Consistency Process
- Federal Consistency Process
- NYS Coastal Policies
- NYS Coastal Management Program
- Federal Register, June 25, 1979-Part V-Department of Commerce - Federal Consistency Regulations

4.2.3 REDUCTION OF TOXICITY, MOBILITY OR VOLUME

Another key criteria which must be evaluated when comparing alternatives is the degree to which alternatives employ technologies which will reduce the toxicity, mobility or volume of waste.

Implementation of the no action alternative will not result in a reduction of contaminated soil toxicity, mobility or volume. Therefore, this alternative does not satisfy this evaluation criteria.

Placing a low permeability cover on-site would not reduce the toxicity or volume of hot spot or other identified contaminated soils. It would, however, significantly reduce the mobility of contaminated particulates. In a similar fashion, off-site RCRA landfill disposal would not decrease the toxicity or volume of hot spot or other identified contaminated soils. The mobility of all soil contaminants both at the landfill and at the school site, however, would be significantly reduced once the soils were appropriately covered.

Solidification/stabilization of the wastes would reduce the mobility of volatile and particulate contaminants and the toxicity of contaminants (depending upon the additives involved). The volume of wastes, however, may increase significantly depending upon the technology selected.Volume increase estimates from manufacturers of solidification/stabilization technologies ranged from a possible slight reduction to a 70 percent increase. In all cases, preliminary testing will be necessary to accurately determine volume changes as a result of treatment.

Thermal treatment of the hot spot soils would reduce their toxicity. The volume of the soils, however, would not be significantly reduced since they consist primarily of inert materials. The volume of the vegetative layer soils from the hot spot area, however, might be significantly reduced because of the higher percentage of organic materials. Since the hot spot soils spot soils would be rendered either less toxic or non-toxic, the mobility of hot spot contaminants would be either significantly lower or non-existant, respectively. The short-term mobility of hot spot contaminants would increase, however, due to materials handling and thermal treatment emissions. Thus the control technologies discussed previously would be required to minimize contaminant mobility on a short-term basis.

4.2.4 SHORT-TERM EFFECTIVENESS

The short-term effectiveness of the alternatives should be assessed based on the following factors:

- Magnitude of reduction of existing risks
- Short-term risks which might be posed to the community, workers, or the environment during implementation of an alternative including potential threats to human health and the environment associated with excavation, transportation, and redisposal or containment
- Time to implement the remedy

As described previously, the no action alternative would not reduce existing risks, and it is anticipated that these risks would increase with time due to the effects of erosion. Since full protection would not be achieved by this alternative, no time can be established for achievement of this goal.

The low permeability cover alternative would virtually eliminate existing risks on a short-term basis since it would not be necessary to disturb the contaminated soils. There might, however, be a slight risk of exposure during use of construction equipment on the surface prior to placement of the low permeability layer of the cover. The estimated time to implement this alternative as well as the other final alternatives is presented on Table 4-4. At this time, it is estimated that implementation of this alternative would take approximately 30 months.

The off-site RCRA landfill disposal alternative would greatly reduce existing risks at the site once the hot spot soils had been removed and transported off-site, and the low permeability cover was placed. Short-term risks which could be incurred during implementation of this alternative were discussed in detail previously. In summary, it was estimated that workers at the site could be adequately protected from all exposure sources by wearing the appropriate respiratory protection and protective clothing while nearby residents and the environment could be protected from airborne and water borne particulates and direct contact by implementation of the appropriate controls. Control of volatile emissions during excavation, transportation and redisposal of the contaminated soils would be virtually impossible. However, these emissions would not be expected to impose significant risks as described previously in the risk assessment. As many as 375 20 c.y. truck loads of hot spot soils would have to be transported to the off-site RCRA landfill. There is a risk that if a truck were to overturn or experience other damage, spillage of the hot spot soils could occur. Finally, the time required to implement this alternative is anticipated to be approximately 36 months as shown on Table 4-4.

The on-site solidification/stabilization alternative would significantly reduce existing risks at the site once the hot spot soils were excavated and treated. The short-term risks associated with this alternative would be essentially the same as those incurred during hot spot soils excavation discussed previously as well as additional risks associated with increased soils handling prior to and during treatment. The time required to implement this alternative has been estimated as 36 months. This estimate is dependent upon whether or not the selected technology would be capable of treating the hot spot soils as they were excavated and the time required to obtain regulatory approval for delisting or acceptability for hybrid landfill disposal of treatment residuals.

The on-site thermal treatment and thermal treatment at Love Canal alternatives would significantly decrease existing risks at the site once thehot spot soils were excavated, thermally treated, and disposed. The degree to which

TABLE 4-4 ESTIMATED REMEDIAL ACTION IMPLEMENTATION TIMES

IMPLEMENTATION ACTIVITIES	NO ACTION	FINAL ALTERNATIVES LOW PERM. COVER	RCRA LANDFILL	SOLID.STAB.
1. Procurement of Design Contractor	NA	2-6 mo.	2-6 mo.	2-6 mo.
2. Completion of Remedial Design	NA	6-12 mo.	6-12 mo.	9-12 mo.
3. Procurement of Remediation Contractor	NA	4-6 mo.	4-6 mo.	4-6 mo.
4. Preliminary Testing	NA	NA	1-2 mo.	1-2 mo.
5. Delisting or Hybrid Landfill Disposal or RCRA Landfill Disposal Approvals	NA	NA	6-18 mo.	6-18 mo.
6. Mobilization/Demobilization	NA	1-2 mo.	1-2 mo.	1-2 mo.
7. Treatment	NA	NA	NA	4-24 mo.
8. Residuals Testing	NA	NA	NA	NA*
9. Approvals for Residuals Disposal	NA	NA	NA	NA*
10. Residuals Disposal	NA	NA	6-9 mo.	NA*
11. Placement of Low Permeability Cover	NA	6-12 mo.	6-12 mo.	6-12 mo.
APPROXIMATE TOTAL: (assuming some concurrent activities)	None	30 mo.	36 mo.	48 mo.

*Included in Treatment Time

TABLE 4-4 ESTIMATED REMEDIAL ACTION IMPLEMENTATION TIMES (Continued)

IMPLEMENTATION ACTIVITIES	FINAL ALTERNATIVES: ON-SITE THERMAL TREATMENT CASE I	ON-SITE THERMAL TREATMENT CASE II	ON-SITE THERMAL TREATMENT CASE III	THERMAL TREATMENT AT LOVE CANAL CASE I	THERMAL TREATMENT AT LOVE CANAL CASE II	THERMAL TREATMENT AT LOVE CANAL CASE III
1. Procurement of Design Contractor	2-6 mo.	2-6 mo.	2-6 mo.	2-6 mo.	2-6 mo.	2-6 mo.
2. Completion of Remedial Design	9-12 mo.	9-12 mo.	9-12 mo.	9-12 mo.	9-12 mo.	9-12 mo.
3. Procurement of Remediation Contractor	4-6 mo.	4-6 mo.	4-6 mo.	4-6 mo.	4-6 mo.	4-6 mo.
4. Preliminary Testing	5-16 mo.	6-18 mo.	5-16 mo.	5-16 mo.	6-18 mo.	5-16 mo.
5. Delisting or Hybrid Landfill Disposal or RCRA Landfill Disposal Approvals	4-7 mo.	6-18 mo.	4-7 mo.	4-7 mo.	6-18 mo.	4-7 mo.
6. Mobilization/Demobilization	8-12 mo.	10-14 mo.	8-12 mo.	NA	1-2 mo.	NA
7. Treatment	2-21 mo.	6-42 mo.	2-21 mo.	4-12 mo.	8-36 mo.	4-12 mo.
8. Residuals Testing	NA*	NA*	NA*	NA*	NA*	NA*
9. Approvals for Residuals Disposal	NA*	NA*	NA*	NA*	NA*	NA*
10. Residuals Disposal	NA*	NA*	NA*	NA*	NA*	NA*
11. Placement of Low Permeability Cover	6-12 mo.	6-12 mo.	6-12 mo.	6-12 mo.	6-12 mo.	6-12 mo.
APPROXIMATE TOTAL: (assuming some concurrent activities)	60 mo.	72 mo.	60 mo.	24 mo.**	36 mo.**	24 mo.**

*Included in Treatment Time
**These Time Periods Begin in 1992

risks would be reduced would depend upon whether or not any byproducts which could not be delisted or disposed by the hybrid approach were generated during thermal treatment. If no such byproducts were generated, the byproducts could be disposed on-site (Cases II and III). If, however, the residual ash and other byproducts could not be delisted or disposed by the hybrid approach, it would be necessary to dispose of these wastes at an off-site RCRA landfill (Case I). As described previously, in addition to excavation and transportation related short-term risks, the on-site thermal treatment alternative would also result in additional short-term risks during feed preparation and thermal treatment. Strict controls would have to be employed to minimize emissions prior to and during thermal treatment for either of these alternatives. The estimated time required to implement these alternatives ranged from 60 to 72 months from the present as shown on Table 4-4.

4.2.5 LONG-TERM EFFECTIVENESS AND PERMANENCE

In this section, the long-term effectiveness and permanence of the alternatives are assessed based on the following factors:

- Magnitude of residual risks in terms of amounts and concentrations of waste remaining following implementation of remedial action.
- Type and degree of long-term management required including monitoring and operation and maintenance
- Potential for exposure of human and environmental receptors to remaining wastes considering the potential threats to human health and the environment associated with excavation, transportation, redisposal, or containment
- Long-term reliability of the engineering and institutional controls, including the uncertainties associated with land disposal of untreated or partially treated soils
- Potential need for replacement of the remedy.
- Time until acceptable level of protection is achieved.

It has been determined that the no action alternative would result in the greatest long-term risks since all identified contaminated soils would remain on-site in an uncontained and untreated condition. Potential risks associated with site contaminants were computed and described in Section 6 of Volume I - Remedial Investigation Summary. Based on these computations, it was determined that if the no action alternative were implemented, unacceptable direct contact risks would be imposed. In addition, this alternative would require that the site be carefully monitored for signs of potential contamination of air, surface water and groundwater at levels exceeding ARARs. Detailed assessments of monitoring data would be required to ensure that levels of contamination were not increasing. Maintenance would also be necessary to minimize the effects of wind and surface water erosion on the vegetative cover at the site and the effects of weathering on pavements overlying contaminated soils. It is likely that even if careful monitoring and maintenance of the site were provided, the local human population and the environment would still be potential receptors of air and water borne contaminated particulates. In addition, if access to the site were not limited, then direct contact exposures could also occur. In conclusion, it is likely that if the no action alternative were selected, it would be found inadequate for protecting human health and the environment and would therefore have to be replaced by another remedy.

The long-term effectiveness of the low permeability cover alternative would be significantly better than that of the no-action alternative. Because this alternative would be capable of separating the identified contaminated soils from air, surface water and direct contact with humans and other life forms; long-term risks of exposure to soil contaminants would be relatively low. However, since the wastes would remain untreated, it would be necessary to monitor the groundwater. It would also be necessary to perform a detailed assessment of alternative performance at least every five years. Maintenance activities would be required to ensure the integrity of the cover and associated components. Providing that monitoring and maintenance were effectively performed, it is anticipated that long-term exposure risks would be minimal. It is also anticipated that the cover would be effective for a very long time period. There are, however, uncertainties involved should a major earthquake or flood of a magnitude greater than 100 years occur. Thus, it is possible that eventually the cover or portions of the cover might have to be replaced.

The long-term effectiveness of the off-site RCRA landfill disposal alternative would be very good at the 93rd Street School site since the hot spot soils would be removed from the site. At the off-site RCRA landfill, it is anticipated that the waste would be disposed and then covered with a RCRA cap which would also be effective for a very long time period.

The long-term effectiveness of the solidification/stabilization alternative is somewhat uncertain since performance will vary depending upon the particular technology selected. The technology selected should be capable of treating the hot spot soils such that they are delistable or capable of meeting hybrid closure requirements and resistant to degradation. This would ensure that wastes would be adequately contained for a long time. It is possible, however, that the solidified/stabilized soils would eventually deteriorate. It is anticipated that the deterioration would be detected during routine monitoring and that at that time the solidified/stabilized soils could either be treated, placed in a more extensive containment, or a new remedial action could be selected.

The long-term effectiveness of the on-site and off-site thermal treatment alternatives would be excellent if the hot spot soils and treatment byproducts could be rendered delistable or capable of meeting hybrid closure rerquirements and therefore decrease the potential for a threat to human health or the environment. Maintenance and monitoring would be required, however, since identified contaminated soils would still be present at the site. If the residual byproducts were hazardous, they would still be somewhat less hazardous than the untreated soils depending upon the degree of treatment attained. Thus disposal of the residual ash at an off-site RCRA landfill (Case I) would result in slightly reduced long-term risks as compared to disposal of the untreated soils at the off-site RCRA landfill. Solidification/stabilization of the residual byproducts followed by disposal on-site and construction of a low permeability cover (Case II) would result in slightly reduced long-term risks as compared to covering of the untreated hot spot soils or solidified/stabilized hot spot soils with an on-site low permeability soil cover.

4.2.6 IMPLEMENTABILITY

In this section, the implementability of each of the final alternatives is assessed based on the following factors:

- Degree of difficulty associated with constructing the technologies
- Expected operational reliability of the technologies
- Need to coordinate with and obtain necessary approvals and permits from other offices and agencies
- Availability of necessary equipment and specialists
- Available capacity and location of needed treatment, storage, and disposal services.

Implementation of the no action alternative would involve simply leaving the wastes in place at the site uncontained and untreated. As described previously, the operational reliability of this alternative for mitigating site problems would be poor since naturally occuring erosion and weathering would degrade the cover materials and eventually lead to migration of contaminants.

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It should be noted, however, that it is anticipated that equipment and specialists for site maintenance and monitoring could easily be acquired in the Niagara Falls area.

Implementation of the low permeability cover alternative would require relatively extensive construction at the site. In addition to construction of the cover, provisions for construction of retaining walls, raised monitoring wells, tree wells, access stairways and other features may be required because of the rise in site elevation. If reuse of the site as a schoolyard was desired, the complexity would increase since parking areas and play areas would have to be considered in the design. The anticipated operational reliability of the low permeability cover alternative would be good providing that adequate maintenance and monitoring were performed. Approvals for covering of the contaminated soils might be required from both the state and EPA. This might prove extremely difficult since soils known to contain greater than 1 ppb dioxin would be present beneath the cover along with other hot spot soils which could pose an increased health risk at the site if ever re-exposed. Finally, it is anticipated that equipment and specialists required for cover design and construction, maintenance, and monitoring would be readily available in the Niagara Falls area.

Implementation of the off-site RCRA landfill disposal alternative would not be difficult technically, and it is anticipated that the operational reliability of the off-site landfill selected would be at least as effective as that of the low permeability cover described above. Obtaining the necessary approvals, transportation and disposal facilities might be difficult, however, since dioxin has been identified in the hot spot soils at the site at levels exceeding 1 ppb. As described earlier, CECOS would not be willing to accept the contaminated soils at their New York facility, and they might not be able to accept the soils at their Ohio facility. In addition, SCA would only accept the soils if it could be proven that they did not contain dioxin at detectable levels, and they might have difficulties accepting all of hot spot soils excavated from the site.

Implementation of the solidification/stabilization alternative would vary in difficulty depending upon the technology selected. Since no technology would be used which would be less effective than a low permeability cover alone, the anticipated operational reliability of this technology would be good. Approval of the selected solidification/stabilization system would be required from both the state and EPA as well as approval for disposing of the solidified/stabilized materials on-site. Availability of necessary equipment and specialists might be more limited than for other alternatives since at the present time, some of these technologies have not been widely accepted for permanently treating soils contaminated with hazardous constituents. Finally, it is anticipated that there would be adequate capacity for disposal of the solidified/stabilized hot spot soils on-site. The site would be somewhat elevated, however, as a result of placement of the low permeability cover over the treated hot spot soils.

Implementation of the on-site thermal treatment alternatives (Cases I-III) would vary in difficulty depending on the mobile unit selected and the disposal method required. Units requiring more extensive feed preparation, treatment of scrubber waters, and disposal of hazardous residuals would be more difficult to implement. The operational reliability of this alternative would also vary depending upon the unit selected.

Routine maintenance and monitoring of the mobile thermal unit would be conducted to ensure reliability and to minimize failure. If failure occurred, then the unit would have to be shut down until the problem could be

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corrected. It should be noted that thermal treatment units at other hazardous waste sites have been proven to be capable of meeting ARARs. In addition, some thermal treatment residues have been successfully delisted. However, according to EPA (Ref. 4), full scale operation of mobile thermal treatment units at hazardous waste sites has been limited, and some units have experienced extended periods of downtime.

Mobile units are currently available for use at the site, and there is sufficient capacity at the 93rd Street School site for disposal of residuals. If, however, the residuals are hazardous, it may be difficult to dispose of them at an off-site RCRA landfill since they initially contained low levels of dioxin. Finally, if hazardous scrubber waters are generated, it is anticipated that they could be transported to the Love Canal leachate treatment plant for treatment.

Implementation of the thermal treatment at Love Canal alternative will be similar to that described previously for the on-site thermal treatment alternative (Cases I-III). There are, however, some additional factors associated with this alternative which could affect its implementability. First, the possibility of including treatment of the 93rd Street School site hot spot soils at the transportable thermal destruction unit (TTDU) to be used at Love Canal for treatment of creek and sewer sediments was not discussed in the Declaration for the Record of Decision signed on October 26, 1987. Therefore, the new Record of Decision for the 93rd Street School should address coordination of treatment of the 93rd Street School site soils at Love Canal if this is the selected alternative. At this time it is anticipated that if this alternative were selected, treatment of the 93rd Street School soils would not begin until 1992. Also, if the 93rd Street School soils had to be stored prior to treatment, storage along with the creek and sewer sediments would have to be coordinated. Finally possible delays in the schedule for thermal destruction of the creek and sewer sediments could delay treatment of the 93rd Street School site as well if this alternative is selected.

4.2.7 COST

Estimated costs for preliminary remedial action alternatives were presented previously in Section 3. The intent of this section is to develop detailed cost estimates for each of the final alternatives. Included are detailed estimates of capital costs; operation, maintenance, monitoring and detailed assessment costs; and net present worths for each of the final alternatives. The Implicit Price Deflators of the GNP as presented in Table 3-1 were used in the development of cost estimates in this section where costs in 1988 dollars were not available. In addition, it should be noted that all capital costs presented in this section were rounded off to the nearest $5,000 while all annual costs were rounded off to the nearest $500.

Estimated costs for the no action alternative are presented in Table 4-5. There will not be any capital expenses associated with this alternative. Periodic expenses will include the costs of quarterly monitoring of the groundwater and surface water at the site; periodic air monitoring at the site; maintenance of the lawn and pavement overlying contaminated soils; and a detailed performance evaluation every five years to assess the effectiveness of this alternative. The quantities of samples to be collected during site monitoring were estimated based on quarterly sampling of the 13 existing monitoring wells at the site (i.e., wells 7135 to 7150 and SMW-1 to SMW-9), quarterly collection and analysis two surface water samples from the existing swale, and annual analysis of three air samples. These samples would be analyzed for a selected set of indicator parameters derived from the list of parameters of concern for the site. Additional groundwater contamination information to be obtained during the remedial design phase will be necessary to develop a final list of parameters. Therefore, at this time it will be assumed that all parameters of concern as defined in Volume I Section 3 should be included.

TABLE 4-5 - NO ACTION ALTERNATIVE COST ESTIMATE

CAPITAL EXPENSE ITEMS		TOTAL COST
1. None	TOTAL:	$0

PERIODIC EXPENSE ITEMS	QTY.	UNITS	COST	TOTAL COST
1. Quarterly Monitoring				
a. Groundwater	52	Sample/Yr.	$2,500.00	$130,000
b. Surface water	8	Sample/Yr.	2,400.00	19,500
2. Periodic Air Monitoring	3	Sample/Yr.	500.00	1,500
3. Site Maintenance				
a. Lawn	35,000	Sq. Yd.	0.25	9,000
b. Paved Areas	5,500	Sq. Yd.	1.00	5,500
4. Detailed Evaluation (every 5 years)	0.2	Eval./Yr.	100,000	20,000
			Sub Total:	$185,500
		20% Eng. and Reg. Contingency:		37,500
			TOTAL:	$223,000

Lawn and pavement maintenance would be performed in an attempt to minimize deterioration of the vegetative layer and pavement overlying contaminated soil. Finally, for this alternative as well as all other alternatives in which untreated wastes will remain on-site, a detailed performance assessment will be required at least every five years. Costs were estimated based on these assumptions, subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $223,000 for the annual cost of the no action alternative.

Estimated costs for the low permeability cover alternative are presented in Table 4-6. Capital expenses will include purchase, transport and placement of all necessary soil layers including underlying fill, low permeability soil for the low permeability layer, topsoil, and vegetation. Also included are capital expenses for raising monitoring wells, reinforcing paved areas overlying non hot spot contaminated soils, constructing structures required to compensate for the rise in site elevation, and performing a final survey. Periodic costs will include semi-annual site inspections, quarterly groundwater monitoring, detailed five year assessments, and maintenance activities to ensure the integrity of the cover, monitoring wells, and other related structures. Cost estimates were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in an estimated capital cost of $1,305,000 and an estimated annual cost of $195,000 for the low permeability cover alternative.

Estimated costs for the off-site RCRA landfill disposal alternative are presented in Table 4-7. Capital expenses associated with this alternative will include the costs for excavating hot spot soils and overlying pavement, transporting the soils to an off-site RCRA disposal facility (assuming 375 loaded trips using 20 c.y. trucks to transport the soils 500 miles), disposal of

TABLE 4-6 - LOW PERMEABILITY COVER ALTERNATIVE COST ESTIMATE

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Clean Fill	25,000	Cu. Yd.	$15.00	$375,000
2. Clay	17,500	Cu. Yd.	20.00	350,000
3. Topsoil	3,000	Cu. Yd.	25.00	75,000
4. Hydroseed, Lime, Fertilizer	8	Acre	1,500.00	15,000
5. Raise Existing Monitoring Wells	5	Well	1,000.00	5,000
6. Reinforce Paved Areas	7,000	Sq. Yd.	7.00	50,000
7. Misc. Structures				190,000
8. Final Survey	500	Man. Hr.	50.00	25,000
			Sub-Total:	$1,085,000
			20% Eng. & Reg. Contingency:	220,000
			TOTAL:	$1,305,000

TABLE 4-6 - LOW PERMEABILITY COVER ALTERNATIVE COST ESTIMATE(Continued)

PERIODIC EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST/YR
1. Semi-Annual Site Inspection	50	Manhr./Yr.	$50.00	$ 2,500
2. Quarterly Groundwater Monitoring	52	Sample/Yr.	2,500.00	130,000
3. Detailed Evaluation (every 5 years)	0.2	Eval./Yr.	100,000.00	20,000
4. Maintenance				
a. Cover Maintenance				2,500
b. Misc. Maintenance				7,500
			Sub-Total:	$162,500
		20% Eng. & Reg. Contingency:		32,500
			TOTAL:	$195,000

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TABLE 4-7 - OFF-SITE RCRA LANDFILL DISPOSAL ALTERNATIVE COST ESTIMATE

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Hot Spot Soil Excavation	7,500	Cu. Yd.	$5.00	$ 40,000
2. Hot Spot Pavement Excavation	3,000	Sq. Yd.	8.00	25,000
3. Transport Hot Spot Soils	187,500	Loaded Mi.	4.00	750,000
4. Disposal of Hot Spot Soils	11,250	Ton	90.00	1,015,000
5. Clean Fill	7,500	Cu. Yd.	15.00	115,000
6. Reconstruct Paved Areas				
a. Base	3,000	Sq. Yd.	5.00	15,000
b. Pavement, 3" thick	3,000	Sq. Yd.	7.00	25,000
7. Place Low Permeability Cover-------See Table 4-6---------------				1,085,000
			Sub-Total:	$3,070,000
			20% Eng. and Reg. Contingency:	615,000
			TOTAL:	$3,685,000

PERIODIC EXPENSE ITEMS				TOTAL COST/YR
1. Semi-Annual Site Inspection	50	Manhr./Yr.	$50.00	$2,500
2. Quarterly Groundwater Monitoring	52	Sample/Yr.	1,300.00	68,000
3. Detailed Evaluation (every 5 years)	0.2	Eval./Yr.	100,000.00	20,000
4. Maintenance				
a. Cover Maintenance				2,500
b. Misc. Maintenance				7,500
			Sub-Total:	$100,500
			20% Eng. and Reg. Contingency:	20,500
			TOTAL:	$121,000

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the hot spot soils at the off-site landfill (including necessary analyses and taxes); placement of clean fill in the excavated area; reconstruction of paved areas and placement of the low permeability cover. Costs for transportation and disposal were based on costs supplied by Chemical Waste Management, Inc. A 500 mile distance was assumed since it may be more difficult than initially anticipated to find a landfill willing or able to accept the contaminated soils. Annual costs associated with this alternative will be similar to those for the low permeability cover alternative except that groundwater monitoring requirements will be somewhat less extensive. In conclusion, estimated capital and annual costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final capital cost estimate of $3,685,000 and a final annual cost estimate of $121,000 for the off-site RCRA landfill disposal alternative.

Cost estimates for the solidification/stabilization alternative are presented in Table 4-8. Capital expenses for this alternative will include the costs for preliminary testing and approvals; excavating hot spot soils and overlying pavement; solidifying/stabilizing the soils on-site (including the costs of mobilization/demobilization, operation, and maintenance during operation); analysis of treated soils to verify delistability or ability to be disposed in a hybrid facility; redisposal of stabilized/solidified soils on site; reconstruction of paved areas; and placement of a low permeability cover. The cost range for solidification/stabilization was estimated based on information provided by the various manufacturers as $50 to $150 per ton. The cost of redisposal of the solidified/stabilized hot spot soils on site was based on an assumed volume increase range of 0 to 70 percent. It should be noted that depending upon the technology selected, the volume increase may vary significantly. Since the cost of redisposal is much less than that of the

TABLE 4-8 - SOLIDIFICATION/STABILIZATION ALTERNATIVE COST ESTIMATE

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Preliminary Testing & Approvals	---	---	$100,000	$100,000
2. Hot Spot Soil Excavation	7,500	Cu. Yd.	$5.00	40,000
3. Hot Spot Pavement Excavation	3,000	Sq. Yd.	8.00	25,000
4. Solidification/Stabilization	11,250	Ton	50.00 to 150.00	565,000 to 1,690,000
5. Sampling/Analysis of Treated Soils	15	Sample	1,000.00	15,000
6. Redisposal of Treated Soils	7,500 to 13,000	Cu. Yd.	5.00	40,000 to 65,000
7. Reconstruct Paved Areas				
a. Base	3,000	Sq. Yd.	5.00	15,000
b. Pavement, 3" thick	3,000	Sq. Yd.	7.00	25,000
8. Place Low Permeability Cover---------See Table 4-6------------				1,085,000
			Sub-Total:	$1,910,000 to $3,060,000
			20% Eng. and Reg. Contingency:	$ 385,000 to $ 615,000
			TOTAL:	$2,295,000 to $3,675,000

PERIODIC EXPENSE ITEMS	TOTAL COST/YR
1. Same as Off-Site RCRA Landfill Disposal Alternative	$ 121,000

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solidification/stabilization processes, however, even if the volume were to increase by as much as 70 percent, it would result in a relatively small percent increase in the total cost. Periodic expenses associated with this alternative will include costs for semi-annual site inspections, quarterly groundwater monitoring, detailed performance evaluations (every five years), and maintenance activities. It should be noted that monitoring costs for this alternative are anticipated to be similar to those for the off-site RCRA landfill disposal alternative since hot spot soils will have been rendered delistable or capable of meeting hybrid closure requirements. In conclusion, the estimated costs for this alternative were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $2,295,000 to $3,675,000 for the capital cost and $121,000 for the annual cost of the solidification/stabilization alternative.

Cost estimates for the on-site thermal treatment alternative (Cases I to III) are presented in Table 4-9. Capital costs associated with Case I will include preliminary testing; excavation of hot spot soils and overlying pavement; mobilization/demobilization and miscellaneous expenses; thermal treatment (including solids handling); sampling and analysis of treatment byproducts; transport of byproducts to an EPA approved off-site RCRA landfill; disposal of byproducts at the off-site RCRA landfill; placement of clean fill; reconstruction of paved areas and construction of a low permeability cover. Estimated costs for on-site thermal treatment using a mobile treatment unit were $450 per cubic yard plus $50 per cubic yard for solids handling. In addition, costs for transportation and disposal of treated byproducts at an off-site RCRA landfill were estimated based on the same assumptions presented previously in the discussion of the off-site RCRA landfill disposal alternative. Annual expenses associated with this alternative are essentially the same as those for

TABLE 4-9 - ON-SITE THERMAL TREATMENT ALTERNATIVE COST ESTIMATE
CASE I

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Preliminary Testing				$500,000
2. Hot Spot Soil Excavation	7,500	Cu. Yd.	$5.00	40,000
3. Hot Spot Pavement Excavation	3,000	Sq. Yd.	8.00	25,000
4. Mobilization/Demobilization of Mobile Treatment Unit and Misc. Expenses	---	---	---	1,000,000
5. Thermal Treatment	7,500	Cu. Yd.	500.00	3,750,000
6. Sampling/Analysis of Byproducts	15	Sample	1,000.00	15,000
7. Transport of Byproducts 375 trucks @ 500 loaded mi.	187,500	Loaded Mi.	4.00	750,000
8. Disposal of Byproducts	11,250	Ton	90.00	1,015,000
9. Clean Fill	7,500	Cu. Yd.	15.00	115,000
10. Place Low Permeability Cover	-----------See Table 4-6-----------			1,085,000
11. Reconstruct Paved Areas				
a. Base	3,000	Sq. Yd.	5.00	15,000
b. Pavement, 3" thick	3,000	Sq. Yd.	7.00	25,000
			Sub-Total:	$8,335,000
	20% Eng. and Reg. Contingency:			1,670,000
			TOTAL:	$10,005,000

PERIODIC EXPENSE ITEMS		TOTAL COST/YR
1. Same as Off-Site RCRA Landfill Disposal Alternative	TOTAL:	$ 121,000

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TABLE 4-9 - ON-SITE THERMAL TREATMENT ALTERNATIVE COST ESTIMATE (Continued)
CASE II

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Thermal Treatment	7,500	Cu. Yd.	$500.00	$3,750,000
2. Mobilization/Demobilization of Mobile Treatment Unit and Misc. Expenses	---	---	---	1,000,000
3. Thermal Treatment Associated Activities Same as Case I Items 1,2,3,6	----See Case I Cost Estimate---			580,000
4. Preliminary Solidification/ Stabilization Testing	---	---	---	100,000
5. Solidification/Stabilization	11,250	Ton	50.00 to 150.00	565,000 to 1,690,000
6. Sampling/Analysis of Treated Soils	15	Sample	1,000.00	15,000
7. Dispose Byproducts On-Site	7,500 to 13,000	Cu. Yd.	5.00	40,000 to 65,000
8. Place Low Permeability Cover---------See Table 4-6-----------				1,085,000
9. Reconstruct Paved Areas				
a. Base	3,000	Sq. Yd.	5.00	15,000
b. Pavement, 3" thick	3,000	Sq. Yd.	7.00	25,000
			Sub-Total:	$7,175,000 to $8,325,000
			20% Eng. and Reg. Contingency:	1,435,000 to 1,665,000
			TOTAL:	$8,610,000 to $9,990,000

PERIODIC EXPENSE ITEMS		TOTAL COST/YR
1. Same as Solidification/Stabilization Alternative	TOTAL:	$121,000

TABLE 4-9 - ON-SITE THERMAL TREATMENT ALTERNATIVE COST ESTIMATE
(Continued)
CASE III

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Thermal Treatment	7,500	Cu. Yd.	$500.00	$3,750,000
2. Mobilization/Demobilization of Mobile Treatment Unit and Misc. Expenses	---	---	---	1,000,000
3. Thermal Treatment Associated Activities Same as Case I Items 1,2,3,6	----See Case I Cost Estimate---			580,000
4. Dispose Byproducts On-Site	7,500	Cu. Yd.	5.00	40,000
5. Place Low Permeability Cover	----------See Table 4-6----------			1,085,000
6. Reconstruct Paved Areas				
a. Base	3,000	Sq. Yd.	5.00	15,000
b. Pavement, 3" thick	3,000	Sq. Yd.	7.00	25,000
			Sub-Total:	$6,495,000
	20% Eng. and Reg. Contingency:			1,300,000
			TOTAL:	$7,795,000

PERIODIC EXPENSE ITEMS		TOTAL COST/YR
1. Same as Off-Site RCRA Landfill Disposal Alternative	TOTAL:	$121,000

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essentially the same as those for the off-site RCRA landfill disposal alternative. In conclusion, estimated capital and annual costs were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final estimate of $10,005,000 for the capital cost and $121,000 for the annual cost of on-site thermal treatment (Case I).

Capital costs for on-site thermal treatment (Case II) will include preliminary testing; excavation of hot spot soils and overlying pavement; thermal treatment (including soils handling); sampling and analysis of treatment byproducts; solidification/stabilization of byproducts; resampling and analysis of treatment byproducts; disposal of byproducts on-site; construction of the low permeability cover and related structures; and reconstruction of paved areas. The periodic expenses associated with this alternative will be the same as those estimated previously for the solidification/stabilization alternative. In conclusion, costs were subtotalled and added to a 20 percent engineering regulatory contingency resulting in final estimates of $8,610,000 to $9,990,000 for the capital costs and $121,000 for the annual cost of on-site thermal treatment (Case II).

Capital costs for the on-site thermal treatment alternative (Case III) include preliminary testing; excavation of hot spot soils and overlying pavement; thermal treatment (including solids handling);mobilization/demobilization and miscellaneous expenses; sampling and analysis of treatment byproducts; disposal of byproducts on site; placement of the low permeability cover and reconstruction of paved areas. Periodic expenses associated with this alternative will be essentially the same as those for the off-site RCRA landfill disposal alternative. Estimated capital and annual costs were subtotalled and added to a 20 percent engineering and regulatory contingency resulting in a final capital cost estimate of $7,795,000 and a final annual cost estimate of $121,000 for the on-site thermal treatment alternative (Case III).

Cost estimates for the thermal treatment at Love Canal alternative (Cases I-III) are presented in Table 4-10. These estimates are very similar to the estimates presented for on-site thermal treatment except that there are additional costs associated with transporting the hot spot soils to the Love Canal TTDU for Cases I and III, there are additional costs associated with transporting the treated residuals back to the site for Cases II and III, and the costs of treatment are slightly lower since the mobile TTDU will have already been approved and mobilized. Based on these assumptions, the estimated capital and annual costs were subtotaled and added to a 20 percent engineering and regulatory contingency resulting in the following final cost estimates for the thermal treatment at Love Canal alternative:

	Capital Cost	Annual Cost
Case I	$8,810,000	$121,000
Case II	$7,425,000 to 8,805,000	$121,000
Case III	$6,610,000	$121,000

TABLE 4-10 - THERMAL TREATMENT AT LOVE CANAL ALTERNATIVE
COST ESTIMATE
CASE I

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Same as On-Site Case I ------See Table 4-9------------------- (Items 1,2,3,6,7,8,9,10,11)				$3,585,000
2. Transport Untreated Hot Spot Soils to Love Canal TTDU (375 Trucks @ 1.5 loaded mi.)	563	Loaded Mi.	$ 4.00	5,000
3. Cost of Treatment	7,500	Cu. Yd.	500.00	3,750,000
			Sub-Total:	$7,340,000
	20% Eng. and Reg. Contingency:			1,470,000
			TOTAL:	$8,810,000

PERIODIC EXPENSE ITEMS		TOTAL COST/YR
1. Same as On-Site Thermal Treatment Case I Alternative	TOTAL:	$ 121,000

TABLE 4-10 - THERMAL TREATMENT AT LOVE CANAL ALTERNATIVE COST ESTIMATE Continued CASE II

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Same as On-Site Case II------See Table 4-9------------------- (Items 3,4,5,6,7,8,9)				$2,425,000 to 3,575,000
2. Transport Untreated Hot Spot Soils to Love Canal TTDU (375 Trucks @ 1.5 loaded mi.)	563	Loaded Mi.	$ 4.00	5,000
3. Cost of Treatment	7,500	Cu. Yd.	500.00	3,750,000
4. Transport Thermal Treatment Byproducts Back to Site (375 Trucks @ 1.5 loaded mi.)	563	Loaded Mi.	4.00	5,000
			Sub-Total:	$6,185,000 to 7,335,000
		20% Eng. and Reg. Contingency:		1,240,000 to 1,470,000
			TOTAL:	$7,425,000 to $8,805,000

PERIODIC EXPENSE ITEMS		TOTAL COST/YR
1. Same as On-Site Thermal Treatment Case II Alternative	TOTAL:	$ 121,000

TABLE 4-10 - THERMAL TREATMENT AT LOVE CANAL ALTERNATIVE
COST ESTIMATE
Continued
CASE III

CAPITAL EXPENSE ITEMS	QTY.	UNITS	UNIT COST	TOTAL COST
1. Same as On-Site Case III----------See Table 4-9-------------- (Items 3,4,5,6)				$1,745,000
2. Transport Untreated Hot Spot Soils to Love Canal TTDU (375 Trucks @ 1.5 loaded mi.)	563	Loaded Mi.	$ 4.00	5,000
3. Cost of Treatment	7,500	Cu. Yds.	500.00	3,750,000
4. Transport Thermal Treatment Byproducts Back to Site (375 Trucks @ 1.5 loaded mi.)	563	Loaded Mi.	4.00	5,000
			Sub-Total:	$5,505,000
	20% Eng.	and Reg.	Contingency:	1,105,000
			TOTAL:	$6,610,000

PERIODIC EXPENSE ITEMS		TOTAL COST/YR
1. Same as On-Site Thermal Treatment Case III Alternative	TOTAL:	$ 121,000

Present worths for the final alternatives are presented in Table 4-11. These present worths were computed based on the same assumptions discussed previously in Section 3. In conclusion, the relative magnitude of these present worth estimates are very similar to those presented previously for the preliminary alternatives. The no-action alternative is the least costly, while the on-site thermal treatment alternatives in which the byproducts cannot be delisted and must be either taken to a RCRA landfill (i.e., Case I) or solidified/stabilized (i.e., Case II) will be the most costly. It should be noted that if a temporary RCRA grade storage facility must be built for storage of the hot spot soils prior to treatment either by solidification/stabilization or a mobile thermal unit, costs may be as much as 3 million dollars greater if a design similar to that proposed for containment of the creek and sewer sediments is used (Ref. 4). Therefore, an additional column has been added to Table 4-11 which includes construction of a storage facility at the 93rd Street School site for the solidification/stabilization and on-site thermal treatment alternatives.

4.2.8 COMMUNITY ACCEPTANCE

Community acceptance of the remedial action alternatives for the 93rd Street School site will be assessed following the public meeting to be held in April 1988.

4.2.9 STATE ACCEPTANCE

State acceptance of the various alternatives will be reflected in review comments on this final draft of the Remedial Investigation/Feasibility Study report for the 93rd Street School site.

4.2.10 CONCLUSIONS

The no action alternative will not provide for adequate protection of human health and the environment as proven in the risk assessment presented in Section 6 of Volume I - Remedial Investigation Summary. Therefore, this

TABLE 4-11 - PRESENT WORTH ANALYSIS OF FINAL ALTERNATIVE COST ESTIMATES
(Costs in Thousands)

ALTERNATIVE	EST. CAPITAL COST	EST. ANNUAL COST	PRESENT WORTH*	PRESENT WORTH* WITH STORAGE FACILITY
No Action	0	$223	$ 2,025	$2,025
Low Permeability Cover	$ 1,305	195	3,075	3,075
Off-Site RCRA Landfill Disposal	3,685	121	4,785	4,785
Solidification/ Stabilization	2,295 to 3,675	121	3,395 to 4,775	6,395 to 7,775
On-Site Thermal Treatment				
Case I	10,005	121	10,695	13,695
Case II	8,610 to 9,990	121	9,710 to 11,090	12,710 to 14,090
Case III	7,795	121	8,895	11,895
Thermal Treatment at Love Canal				
Case I	8,810	121	9,910	9,910
Case II	7,425 to 8,805	121	8,525 to 9,905	8,525 to 9,905
Case III	6,610	121	7,710	7,710

*Based on a discount rate of 10 percent and a performance period of 25 years; P/A factor is equal to 9.077.

alternative was not considered feasible for remediation of the 93rd Street School site.

Containment alternatives evaluated in this feasibility study were as follows:

- Placement of a low permeability cover over both hot spot soils and other identified contaminated soils at the site
- Disposal of hot spot soils at an approved off-site RCRA landfill followed by placement of a low permeability cover over other identified contaminated soils at the site

Since neither of these alternatives provide for treatment of the hot spot soils, the 1 ppb level of concern established for dioxin will not be addressed. In addition, risks associated with leaving the other hot spot soils at the site are significantly greater if these soils are not treated primarily because of the PAHs and arsenic.

The solidification/stabilization alternative will be selected if it can be confirmed during preliminary testing that the technology is permanent and capable of rendering the soils delistable or disposable in a hybrid landfill. If these criteria can be met, it is anticipated that this alternative will be capable of adequately protecting human health and the environment, meeting ARARs, and reducing the toxicity and mobility of contaminants. In addition, although it is possible that volume increases could be as great as 70 percent, all manufacturers contacted during this study felt that volume increases would probably be in the range of 10 to 30 percent. The short-term effectiveness of this alternative will probably be less protective than for the no-action or containment technologies due to the need for increased solids handling. It is anticipated, however, that controls can be used to minimize the short-term risks. The implementability of this alternative is expected to be quite good since almost all manufacturers contacted believed that they could begin preliminary testing and treatment as soon as approvals were obtained. Finally,

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even if a storage facility must be built at the site to contain the hot spot soils prior to treatment, the cost of this alternative is anticipated to be lower than that of almost all of the thermal treatment alternatives with the possible exception of thermal treatment at Love Canal (Case III).

The most effective of the thermal treatment alternatives considered are anticipated to be on-site thermal treatment (Case III) and thermal treatment at Love Canal (Case III) in which treatment byproducts will be rendered delistable or disposable in a hybrid landfill. If these criteria can be met, these alternatives will be capable of adequately protecting human health and the environment, meeting ARARs, and reducing the toxicity and mobility of contaminants. Significant volume changes are not expected. The short-term effectiveness of these alternatives will be somewhat lower than that of the no action, containment or solidification/stabilization alternatives both because of increased solids handling and thermal treatment emissions. It is anticipated, however, that controls can be used to minimize short term risks. The implementability of the on-site thermal treatment alternative is expected to be similar to that of the solidification/stabilization alternative. The implementability of the thermal treatment at Love Canal alternative, however, may be complicated by the fact that soils from the 93rd Street School site will not be remediated until 1992 following completion of remediation of the creek and sewer sediments. Finally, the costs of the on-site thermal treatment alternative (Case III) is anticipated to be significantly higher than that of the thermal treatment at Love Canal (Case III) as well as than that of the no action, containment, and solidification/stabilization alternatives.

In conclusion, it appears that unless the preliminary testing of the solidification/stabilization alternative indicates that the final product will not be permanently rendered delistable or suitable for hybrid landfill disposal, this alternative is recommended for remediation of the 93rd Street School site.

Appen. A

APPENDIX A

REFERENCES

REFERENCES

1. EPA, Handbook: Remedial Action at Waste Disposal Sites (Revised), EPA/625/6-85/006 (October 1985)

2. CH_2M Hill, Love Canal Sewers and Creeks Remedial Alternatives Evaluation and Risk Assessment EPA 138.2L05.0 (March 1985)

3. Sims, Ronald et al, Contaminated Surface Soils In-Place Treatment Techniques, Noyes Publications, Park Ridge, New Jersey 1986

4. EPA, Alternatives for Destruction/Disposal of Love Canal Creek and Sewer Sediments - Draft (June 1987)

5. Seelye, Elwyn E., Design-Data Book for Civil Engineers, John Wiley and Sons, Inc., New York, New York, 1960

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Appen. B

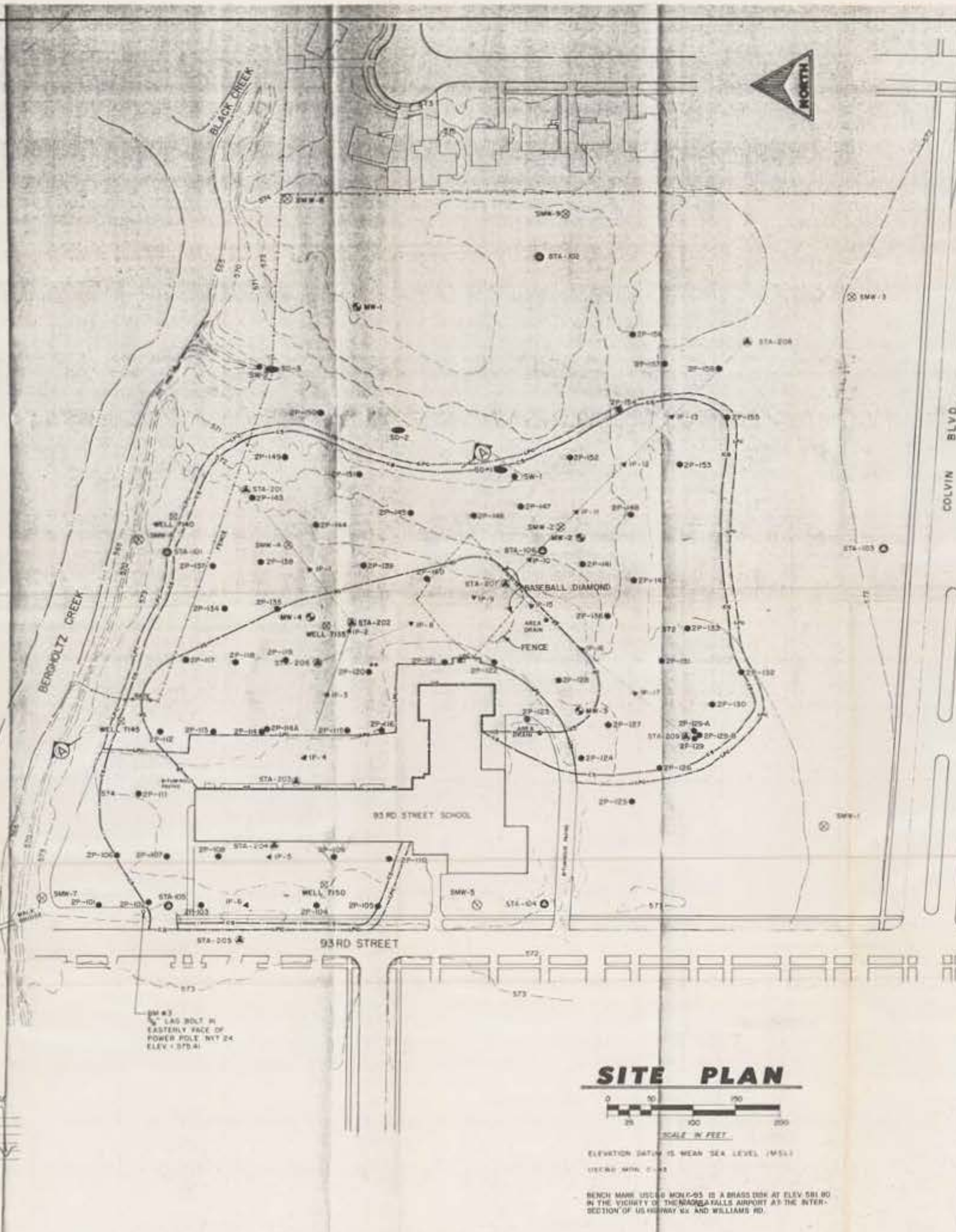
APPENDIX B

DRAWING RAI

MONITORING WELL DATA					
WELL NO.	ELEVATIONS (MSL)				DEPTH (F.T.)
	TOP-PROT. CASING	TOP-WELL CASING	GROUND SURFACE	BOTTOM OF WELL	
SMW-1	574.39	574.13	572.5	552.9	19.6
SMW-2	574.37	574.12	572.7	557.7	15.0
SMW-3	573.98	573.69	572.2	553.1	19.1
SMW-4	575.08	574.87	573.5	559.9	13.6
SMW-5	575.78	575.49	574.0	558.5	15.5
SMW-6	574.74	574.43	573.0	553.3	19.7
SMW-7	575.58	575.33	574.1	554.3	19.8
SMW-8	576.07	575.81	574.2	555.0	19.1
SMW-9	576.00	575.87	573.5	557.4	16.1
MW-1	575.26*		573.1		32.5***
MW-2	574.64*		571.1		31.0***
MW-3	575.01*		573.2		31.5***
MW-4	575.50*		573.5		31.3***
7135	576.77*	576.7	573.3	547.9**	22.5
7140	577.03*	576.78	573.5	548.6**	25.6
7145	577.56*	577.43	573.9	549.2**	24.0
7150	577.55*	577.22	574.2	548.9**	25.3

NOTES:

1. TOPS OF CASINGS ARE WITH CAPS OR COVERS REMOVED EXCEPT THOSE INDICATED WITH * ARE TOP OF COVER.
2. GROUND SURFACE ELEVATIONS ARE APPROXIMATE.
3. ELEVATIONS REPORTED BY E.C. JORDAN INDICATED WITH **.
4. *** DEPTHS BASED ON RECRA LOGS; WELLS EXTEND INTO BEDROCK.
5. SECOND ROUND BORING SAMPLE LOCATIONS 2P-101 AND 2P-156 WERE DELETED.



ELEVATION DATUM IS MEAN SEA LEVEL (MSL)

(A) SECTION

SCALE IN FEET

VERTICAL- NOT TO SCALE

LEGEND

- EXISTING MONITORING WELL LOCATION
- FIRST ROUND MONITORING WELL LOCATION BY LEA
- MAIN BASE LINE STATION
- BORING SAMPLE BASE LINE STATION
- FIRST ROUND BORING SAMPLE LOCATION BY LEA
- E.C. JORDAN CO MONITORING WELL LOCATION
- FIRST ROUND SURFACE WATER SAMPLE LOCATION BY LEA
- DUAL MONITORING WELLS (NOT IN USE)
- EXISTING CONTOUR
- SECOND ROUND SEDIMENT SAMPLE LOCATION BY LEA
- SECOND ROUND BORING SAMPLE LOCATION BY LEA
- EXTENT OF IDENTIFIED CONTAMINATED SOILS
- EXTENT OF IDENTIFIED HOT SPOT SOILS
- APPROXIMATE EXTENT OF PROPOSED LOW PERMEABILITY COVER

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

THOMAS C. JORLING, COMMISSIONER

DIVISION OF HAZARDOUS WASTE REMEDIATION

MICHAEL J. O'TOOLE JR.,P.E., ACTING DIRECTOR

EXTENT OF IDENTIFIED CONTAMINATED SOILS AND PROPOSED LOW PERMEABILITY COVER

LOUREIRO ENGINEERING ASSOCIATES

CONSULTING ENGINEERS

REMEDIAL INVESTIGATION / FEASIBILITY STUDY FOR NYSDEC

93rd STREET SCHOOL SITE NIAGARA FALLS, NY

RA-1

K.M.R., J.K.K. | J.L. | 1" = 50' | MARCH '89